Anritsu

MW9070A

Optical Time Domain Reflectometer

Operation Manual

■ Read this manual before using the equipment. Keep this manual with the equipment.

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MW9070A
Optical Time Domain Reflectometer
Operation Manual

Fifteenth Edition

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Measuring Instruments Division
Measurement Group
ANRITSU CORPORATION

Document No.: M-W0683AE-15.0

Safety Symbols

To prevent the risk of personal injury or loss related to equipment malfunction, Anritsu Corporation uses the following safety symbols to indicate safety-related information. Insure that you clearly understand the meanings of the symbols BEFORE using the equipment.

Symbols used in manual

DANGER

This indicates a very dangerous procedure that could result in serious injury or death if not performed properly.

WARNING

This indicates a hazardous procedure that could result in serious injury or death if not performed properly.

CAUTION

This indicates a hazardous procedure or danger that could result in light-to-severe injury, or loss related to equipment malfunction, if proper precautions are not taken.

Safety Symbols Used on Equipment and in Manual

(Some or all of the following five symbols may not be used on all Anritsu equipment. In addition, there may be other labels attached to products which are not shown in the diagrams in this manual.)

The following safety symbols are used inside or on the equipment near operation locations to provide information about safety items and operation precautions. Insure that you clearly understand the meanings of the symbols and take the necessary precautions BEFORE using the equipment.

This indicates a prohibited operation. The prohibited operation is indicated symbolically in or near the barred circle.

This indicates an obligatory safety precaution. The obligatory operation is indicated symbolically in or near the circle.

This indicates warning or caution. The contents are indicated symbolically in or near the triangle.

This indicates a note. The contents are described in the box.

These indicate that the marked part should be recycled.

MW9070A
Optical Time Domain Reflectometer
Operation Manual

15 May 1993 (First Edition)
17 October 1996 (Fifteenth Edition)

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Printed in Japan

For Safety

WARNING ⚠

1. ALWAYS refer to the operation manual when working near locations at which the alert mark shown on the left is attached. If the operation, etc., is performed without heeding the advice in the operation manual, there is a risk of personal injury. In addition, the equipment performance may be reduced.
   Moreover, this alert mark is sometimes used with other marks and descriptions indicating other dangers.

2. Laser radiation warning
   - NEVER look directly into the cable connector on the equipment nor into the end of a cable connected to the equipment. If laser radiation enters the eye, there is a risk of injury.
   - Laser Radiation Markings on a following page shows the Laser Safety label attached to the equipment near the cable connector.

3. This equipment cannot be repaired by the user. DO NOT attempt to open the cabinet or to disassemble internal parts. Only Anritsu-trained service personnel or staff from your sales representative with a knowledge of electrical fire and shock hazards should service this equipment. There are high-voltage parts in this equipment presenting a risk of severe injury or fatal electric shock to untrained personnel. In addition, there is a risk of damage to precision parts.

Repair

For Safety

CAUTION ⚠

1. Do not use any AC adapter other than the supplied accessory adapter. If another adapter is used, it may not meet the required specifications and the OTDR may be damaged.

   Grounding
   When the AC adapter is used, connect the ground line to earth. The OTDR may be damaged if the AC adapter is not grounded or there may be a danger of an electric shock.

2. Insert the batteries with the correct polarity when the Dry-Cell Batteries are used, or the electrolyte may leak or the battery may explode.

   Never mix new and old batteries, or different types of batteries.

   Be sure not to short the battery pack contacts when it is detached.

   Do not dispose of batteries by incineration.

3. Use the SWA1702W ac adapter within doors. It is not designed for outdoor use.

Laser Radiation Markings

This equipment uses parts radiating Class 1 or Class 2 laser radiation. The warning labels shown below are attached near the laser-radiation locations.

The danger classification specified by JIS, IEC825 and 21CFR1040.10 are explained below.

	OTDR light source	Visible LD light source
IEC825	Class 1	Class 2
21 CFR 1040.10	Class 1	Class 2

Class 1 and Class 2 indicates the degree of danger of the laser radiation outlined below as defined by JIS, IEC825 and 21CFR1040.10.

Class 1 Safe laser presenting no danger when used according to design specifications.

Class 2 Laser radiating in 400 to 700 nm wavelength range. In principal, this class of laser is not safe, but the danger to the eyes is eliminated by the eye avoidance reaction including the blink response.

Label Attachment Positions

Aperture Label

AVOID EXPOSURE–
Visible Laser radiation is emitted from this aperture

(21CFR 1040.10, only for US customers)

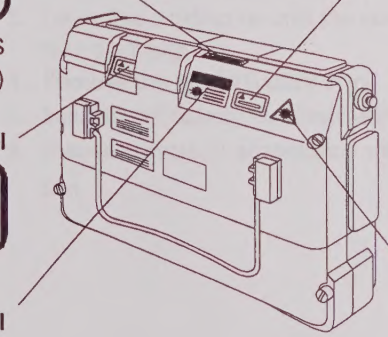
Class-1 Safety Label

CLASS 1 LASER PRODUCT

Class-2 Safety Label
(Only for optical unit option 05)

CAUTION
LASER RADIATION
DO NOT STARE
INTO BEAM
1mW MAX.
CW 635nm
CLASS 2 LASER PRODUCT

(21CFR 1040.10, only for US customers)



Class-2 Safety Label
(Only for optical unit option 05)

VISIBLE LASER RADIATION
DO NOT STARE INTO BEAM
1mW MAX. CW 635nm
CLASS 2 LASER PRODUCT

(IEC 825)

Laser Symbol (Attached when visual LD light source installed)

This international laser symbol indicates that the equipment uses class 2 laser light.

FOR US CUSTOMERS
Please Recycle.

Ni-Cd

The product that you have purchased contains a rechargeable battery. The battery is recyclable. At the end of it's useful life, under various state and local laws, it may be illegal to dispose of this battery into the municipal waste stream. Check with your local solid waste officials for details in your area for recycling options or proper disposal.

Before disposing of this product, discharge the battery, and then mail the battery to your local recycling center.

1. Disconnect the ac adapter, if used.
2. Turn the power switch to on.
3. Leave the product on until the power indicator goes off; the battery is now discharged.
4. Remove the Ni-Cd Battery Pack.
5. Insulate the battery terminals with adhesive tape.
6. Mail it to your local recycling center, or to the following address.

ANRITSU WILTRON COMPANY
685 Jarvis Drive, Morgan Hill, CA 95037, USA

FOR EU•EFTA CUSTOMERS

Please Recycle.

Ni-Cd

Read the following when using products to which the mark shown on the above is attached.

The product that you have purchased contains a rechargeable battery. The battery is recyclable. At the end of its useful life, under various state and local laws, it may be illegal to dispose of this battery into the municipal waste. Check with your local solid-waste disposal officials for details of recycling options or proper disposal in your area.

Before disposing of this product, discharge the battery, and then mail the battery to your local recycling centre.

1. Disconnect the ac adapter, if used.
2. Turn the power switch to on.
3. Leave the product on until the power indicator goes off; the battery is now discharged.
4. Remove the Ni-Cd Battery Pack.
5. Insulate the battery terminals with adhesive tape.
6. Please recycle in accordance with your national or regional legislation.

Equipment Certificate

Anritsu Corporation certifies that this equipment was tested before shipment using calibrated measuring instruments with direct traceability to public testing organizations recognized by national research laboratories including the Electrotechnical Laboratory, the National Research Laboratory and the Communication Research laboratory, and was found to meet the published specifications.

Anritsu Warranty

Anritsu Corporation will repair this equipment free-of-charge if a malfunction occurs within 1 year after shipment due to a manufacturing fault, provided that this warranty is rendered void under any or all of the following conditions.

- The fault is outside the scope of the warranty conditions described in the operation manual.
- The fault is due to misoperation, misuse, or unauthorized modification or repair of the equipment by the customer.
- The fault is due to severe usage clearly exceeding normal usage.
- The fault is due to improper or insufficient maintenance by the customer.
- The fault is due to natural disaster including fire, flooding and earthquake, etc.
- The fault is due to use of non-specified peripheral equipment, peripheral parts, consumables, etc.
- The fault is due to use of a non-specified power supply or in a non-specified installation location.

In addition, this warranty is valid only for the original equipment purchaser. It is not transferable if the equipment is resold.

Anritsu Corporation will not accept liability for equipment faults due to unforeseen and unusual circumstances, nor for faults due to mishandling by the customer.

Anritsu Corporation Contact

If this equipment develops a fault, contact Anritsu Corporation or its representatives at the adress in this manual.

CE Marking

Anritsu affix the CE Conformity Marking on the following product(s) accordance with the Council Directive 93/68/EEC to indicate that they conform with the EMC directive of the European Union (EU).

CE Conformity Marking

CE

1. Product Name/Model Name

Product Name: MW9070 Series Optical Time Domain Reflectometer and Plug-in Units

Model Name: MW9070A/B, MW097X□X, MZ5018A, MZ5020A, SWA1702W

2. Applied Directive

EMC : Council Directive 89/336/EEC

Safety: Council Directive 73/23/EEC

3. Applied Standards

EMC:

Electromagnetic radiation:

EN55011(ISM, Group 1, Class A equipment)

Immunity:

EN50082-1

		Performance Criteria*
IEC801-2 (ESD)	4 kVCD, 8 kVAD	B
IEC801-3 (Rad.)	3 V/m	A
IEC801-4 (EFT)	1 kV	B

*: Performance Criteria

A: No performance degradation or function loss

B: Self-recovered temporary degradation of performance or temporary loss of function

Safety:

EN61010-1 (Installation Category II, Pollution Degree 2)

Introduction

This operation manual explains the operation, calibration and maintenance of the MW9070A Optical Time Domain Reflectometer (OTDR). In particular, make sure that you thoroughly understand the basic functions and operations described in Section 1. Further details are given in subsequent sections.

The symbol indicates related sections with more detailed descriptions.

See the operation map in section 4 for the operational sequence.

This equipment can be controlled by a computer which can also analyze the measurement results; refer to the following operation manual for details of the computer interface.

MW9070A Serial Interface Operation Manual (M-W0751AE)

MS-DOS is a registered trademark of Microsoft Corporation.

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Section 1 Outline

This section explains the functions of the MW9070A and the equipment composition. Refer to Appendix A for the performance and functions, and to Appendix B for the options and related equipment.

1.1 Searching for Faults Automatically
Full AutoMode/Auto Mode 3

1.2 Detailed Measurement
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1.3 Useful Functions 5

1.4 Loss Measurement and
Splice & Return Loss Measurement 6

1.5 Linear Approximation Methods
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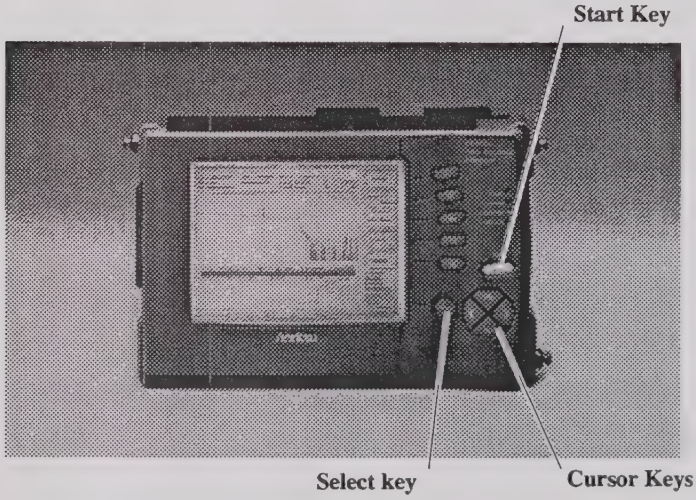
The MW9070A Optical Time Domain Reflectometer (OTDR) has been developed for finding faults in optical fibers when installing and maintaining optical fiber systems. It can be used to measure total loss, interval loss, splice loss and cable length (distance).

The automatic measurement procedure and the small lightweight portable design make it very easy to use at field installation and maintenance of optical fibers. In addition, the internal memory can save measured waveforms for subsequent analysis and print-out. The MW9070A also has an interface for connecting a computer to process measurement results.

Faults are located and losses are measured automatically by just pressing the [Start] key after setting the measurement conditions at the Setup screens.

Automatic Fault Location	Full Auto Mode/Auto Mode
Loss and Splice Loss Measurement	Manual Mode

When the visible light option is used, leak of the light from the cable can be seen.



Measuring Cable Loss and Distance

The laser light (wavelength λ) launched into the optical fiber cable from the OTDR is scattered as it passes to the far end of the cable. Part of this scattered light returns to the OTDR as backscattered light. The strength of this backscattered light is measured and used to find the cable loss. In addition, the time taken from when the optical pulse is launched into the fiber until it returns to the OTDR from a fault is used to calculate the distance to the fault. The cable loss and distance data are stored in the OTDR memory and displayed as a waveform on the screen. For accurate measurement, the light launched into the fiber must pass to the far end of the cable and return to the OTDR as backscattered light before the next optical pulse is launched into the fiber. Therefore, the length of the measured cable is set as the Distance Range on the Setup screens. When the Distance range and Pulse width are set to Auto, the MW9070A sets the optimum values automatically.

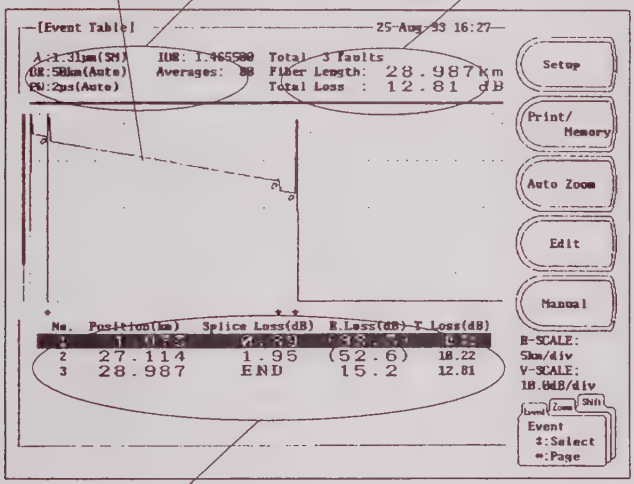
1.1 Searching for Faults Automatically •••Full Auto Mode/Auto Mode

In this mode, faults in the cable are detected and displayed after about 3 minutes just by pressing the [Start] key. Set the measurement mode at the Setup screen to Full Auto or Auto, then the following screen is displayed when measurement is finished. Faults are indicated by the ◇ (event) symbol and the fault data is displayed under the waveform. The faults are called events and this display is called an Event Table.

In the Full Auto mode, the optimum Distance range and Pulse width values are found by the MW9070A. In the Auto mode, measurment is performed using the values for these parameters set at the Setup screen.

For details, see section 4.1.

Trace Waveform **Measurement Conditions** **Search Results**



Event Table

- **Trace Waveform**

The trace waveform is displayed with the attenuation on the y-axis and the distance on the x-axis. The left end of the trace display is the OTDR optical output and the right end is the far end of the fiber cable. The ◇ symbol is displayed at faults in the cable.

- **Measurement Conditions**

Light Wavelength (λ), Distance Range (DR), Pulse Width (PW),
Index of Refraction (IOR), Number of Averagings (Average)

- **Search Results**

Total number of Faults (Total), Total Fiber Length (Fiber Length), Total Loss of Entire Fiber (Total Loss)

- **Event Table**

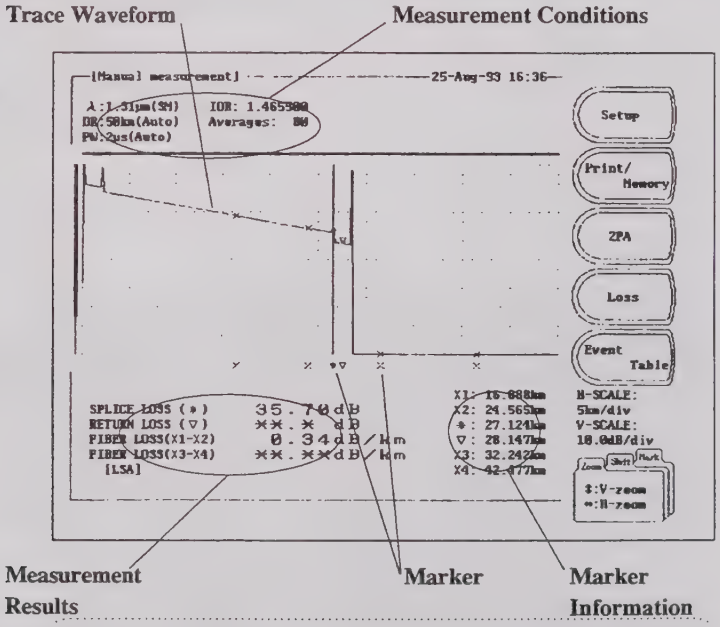
Number of Fault counted from Left (No.), Distance from OTDR (Position), Splice Loss, Return Loss (R. Loss), Total Loss to the Fault (T. Loss)

1.2 Detailed Measurement ••• Manual Mode

In this mode, any position on the fiber can be measured by moving the markers to it. Press the [Start] key after the measurement mode has been set to Manual on the Setup screen. In this mode, select Loss to find the cable total loss, and select Splice & Return Loss to find the connection loss. Two markers are displayed for Loss measurement and six markers are displayed for Splice & Return Loss measurement. The vertical cursor is displayed at the selected marker. The measured values are displayed at the bottom of the screen. Furthermore, in this mode, either the Averaging mode, which averages the measured value for each sweep, or the Real time mode, which re-writes the waveform at each sweep, can be selected.

The following diagram shows a Splice & Return Loss measurment example.

For further details, see section 4.2.



- **Trace Waveform**
  The trace waveform is displayed with the attenuation on the y-axis and the distance on the x-axis.
- **Measurement Conditions**
  Light Wavelength (λ), Distance Range (DR), Pulse Width (PW),
  Index of Refraction (IOR), Number of Averagings (Average)
- **Measurement Results**
  Splice Loss, Return Loss
  Loss between Marker ×1 and ×2 (Fiber Loss ×1 - ×2)
  Loss between Marker ×3 and ×4 (Fiber Loss ×3 - ×4)
- **Marker**
  Six markers are displayed on this screen. The numbers ×1, ×2, ×3, and ×4 are appended to the markers from the left.
- **Marker Information**
  The position information at each marker and for the OTDR is displayed.

1.3 Useful Functions

See the operation map in ☞ Page 44 for the operation method.

Editing event points

☞ See section 4.1.2.

When searching automatically for faults in the Auto mode, there is a possibility of misidentifying normal points as faults or of missing real faults as a result of noise. By changing to the Edit mode when the waveform is displayed, misidentified faults can be eliminated or moved and new events can be added.

Averaging and Real Time functions

☞ See section 4.2 (1).

The strength of the backscatter light changes with distance. The effect is particularly large when the fiber far end is close and is observed on the screen as noise. When the Averaging function is set to ON, the value measured each time the optical pulse is launched into the fiber is averaged so the noise is reduced and a smoother waveform is observed. The Averaging completion conditions can be set at the Setup menu either as the Averaging Time or the No. of Averagings. When the [F2] (Real Time) key is pressed, the screen data is re-written at each sweep and real-time measurement is performed.

Saving and reading measured waveforms

☞ See section 4.4.

The waveform displayed on the screen can be saved either in the MW9070A internal memory or in a memory card. These waveforms can be read or printed at a printer connected to the OTDR. In the Analysis mode, searching for faults and measuring loss or distance with markers can be available on the read waveform. See Appendix B for the number of waveforms which can be saved.

Changing from Manual mode to Auto mode

☞ See section 4.2.2.

When searching for faults using data that has been collected in the Manual mode, the event marker is displayed at the fault and the Event Table is displayed. This method reduces the fault misdetection rate because it can use waveforms that have been averaged over sufficient time. It is also possible to edit event points in the same manner as the Auto mode.

Preview

☞ See section 3.4

In the Preview mode, the waveform trace is refreshed about every 0.9 seconds permitting checking of the waveform while adjusting connectors, etc.

Auto Power-off and Automatic Waveform Save Functions

☞ See section 3.2.2

When a key or button is not pressed for a specified time. the power is switched off automatically . At auto power-off, the waveform is saved automatically . The Setup screen is displayed at the next power-on and the stored waveform is re-displayed when the [F5] (Close) key is pressed.
When the power is switched off manually, the waveform is not saved automatically.

Outputting Visible Light

☞ See section 3.5

An optical unit of light source with 635 nm wavelength is available as an option. Since the light of the unit is visible, the leak of the light from the cable can be seen to find faults in the dead zone of the OTDR, and to collate the core of fibers.

1.4 Loss Measurement and Splice & Return Loss Measurement

In the Manual mode, either Loss measurement or Splice & Return Loss measurement can be selected.

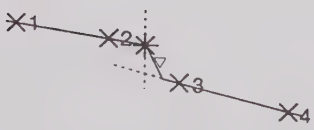
(1) Loss Measurement

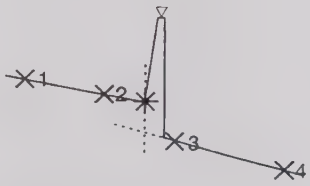
This measures the loss between any two points on the fiber.
The distance between the two points and the fiber loss (loss per unit length) are also displayed simultaneously. The × and ✳ markers are used for this measurement.

(2) Splice & Return Loss Measurement

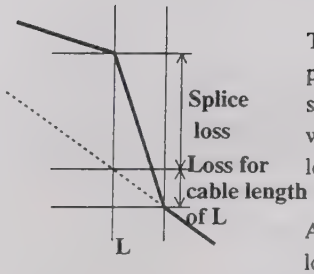
This measures the loss at a connection or splice. The ✳ marker is set at the connection point and then a pair of × markers is set on each side of the ✳ marker as shown in the diagram below. If Fresnel reflection is generated by the connection, a ▽ marker is set at the peak point.

The four × markers are called ×1, ×2, ×3, and ×4 from the left. The splice loss is found from the vertical difference at the ✳ marker between straight lines drawn between the ×1 and ×2, and ×3 and ×4 markers.





The distances between the ×1 and ×2 markers and between the ×3 and ×4 markers as well as the fiber loss (loss per unit length) is also displayed.



There is a section at the splice where the backscattered light cannot be measured precisely during the time corresponding to the pulse width. The distance L shown in the diagram on the left corresponds to this section. As a result of this L, when splice loss is measured using the same method as in Loss Measurement, the loss of the cable L section is included.

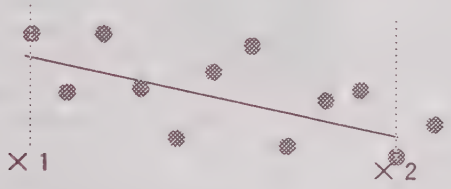
Appendices C and D give more details about measuring splice loss and return loss, respectively.

1.5 Linear Approximation Methods ••• LSA/2PA

At Loss Measurement and Splice Return & Loss Measurement, the loss is found by drawing an imaginary line between two set markers. There are two methods for drawing the line.

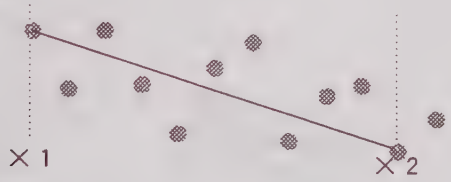
LSA (Least Square Approximation) Method

In this method, the line is drawn by computing the least square of the distances from all the measured data between the two markers. It is very effective when there is a lot of noise in the measurement data. See Appendix C for further details.



2PA (Two Point Approximation) Method

This method draws the line linking the two measured data points at the two markers.

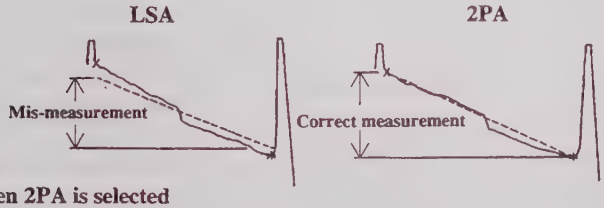


Comparison on LSA and 2PA

These two methods are compared for Loss and Splice Loss & Return measurement when there is a lot of noise as follows:

When LSA is selected

When LSA is chosen at Loss measurement, there is a chance of a large error occurring when measuring a fiber with a splice loss along its length.



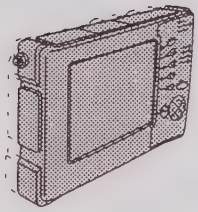
When 2PA is selected

There is a chance of a large error occurring when the noise is large. An example for Splice & Return Loss measurement is shown below.

1.6 Equipment Composition

The MW9070A is composed of the main frame, optical unit and battery pack.

See Appendix A for the list of options, peripheral equipment and related parts.



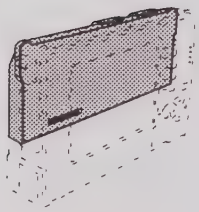
Main Frame

The optical unit is mounted in the main frame which is powered by the installed battery pack. The main frame can also be powered by 100/200 Vac system when the AC adapter is connected. If the main frame is powered by 100/200 Vac system while the battery pack is installed, the battery pack will be recharged too. The main frame can be operated on 100/200 Vac system without the battery pack installed.

When the optional floppy disk drive is installed in the main unit, waveforms in the internal memory can be saved to a 3.5-inch floppy disk. Also, data saved on a floppy disk can be copied to the internal memory. The disk file format is the same as that of internal memory and memory cards.

Optical Unit

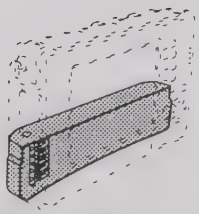
The following two optical units can be chosen according to the wavelength to be used for measurement. The wavelength should match the optical wavelength used by the system, and can be set to 1.55 μm for more detailed checks of faults at bends in the cable.



SM Fiber 1.31 μm Optical Unit	**MW0970A**
SM Fiber 1.31/1.55 μm Optical Unit	**MW0972A**
GI Fiber 0.85 μm Optical Unit	**MW0973J**
GI Fiber 0.85/1.3 μm Optical Unit	**MW0975J**

Additionally, when specifying the optical connector, append the 2 digits with a hyphen to the model as shown below. If these 2 digits are not appended, the unit will be supplied with an FC connector.

Optical unit with HMS-10/A connector	**-43**	**(SM Unit)**
Optical unit with FC connector	**-37**	**(SM/GI Unit)**
Optical unit with ST connector	**-38**	**(SM/GI Unit)**
Optical unit with DIN connector	**-39**	**(SM/GI Unit)**
Optical unit with SC connector	**-40**	**(SM/GI Unit)**
Optical unit with D4 connector	**-21**	**(SM/GI Unit)**
Optical unit with Biconic connector	**-22**	**(SM/GI Unit)**
Optical unit with HFS-13/A connector	**-42**	**(GI Unit)**
Optical unit with Amphenol 906 connector	**-23**	**(GI Unit)**



Battery Pack

Two types of battery packs are available:

Ni-Cd Battery Pack	MZ5018A
Dry-Cell Battery Pack	MZ5020A

The Ni-Cd Battery Pack is re-chargeable. The Dry-Cell Battery Pack accomodates 10 C size dry-cell batteries. Please prepare those dry-cell batteries before use.

Section 2 Before Use

This section provides important information that should be understood before actually using the MW9070A. In particular, it explains how to charge the battery pack at first use after purchasing the OTDR.

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2.16 Fitting Band 23

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2.1 Unpacking

Remove the OTDR and accessories after undoing the packing case. Save the packing case and spacers, etc. if it might be reshipped again sometime. The standard OTDR consists of the following items. If any part is missing or if the OTDR has been damaged in transport, contact your sales representative immediately.

Table 1 List of Parts and Accessories

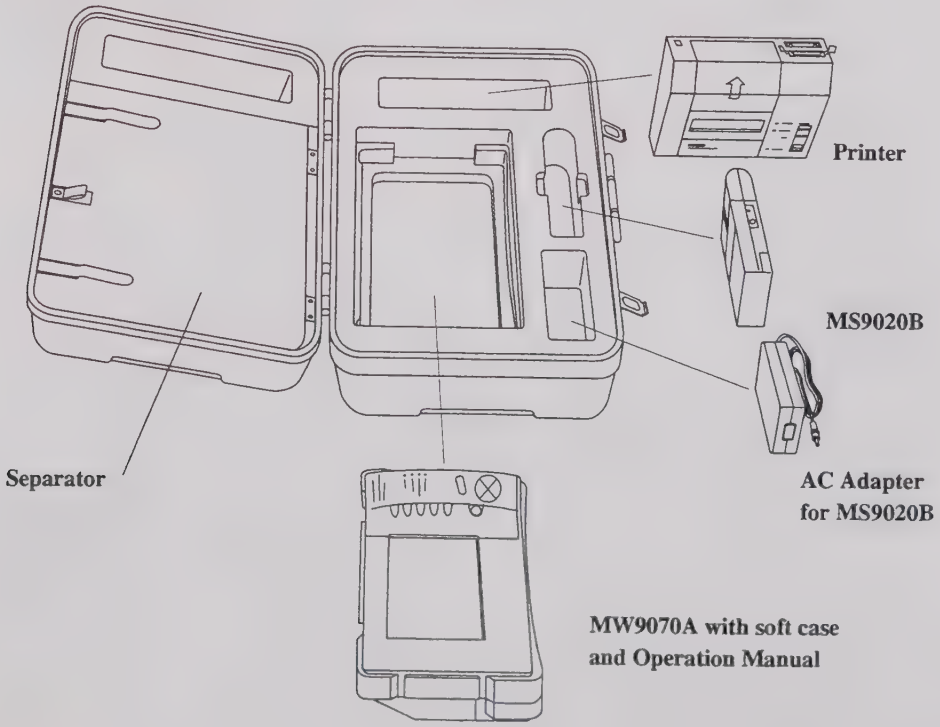
Item	Name	Qty.	Remarks
Main Unit	OTDR	1	MW9070A
	Opticcal Unit	1	MW0970A, MW0972A MW0973J or MW0975J
	Battery Pack	1	MZ5018A or MZ5020A
Accessories	AC Adapter	1	SWA1702W
	Power Cord(2.5 m)	1	J0017
	Operation Manual	1	W0683AE
	Service Manual	1	W0683BE
	Serial Interface Operation Manual	1	W0751AE

Note: Refer to the factory packing lists for the parts and accessories when there are special specifications.

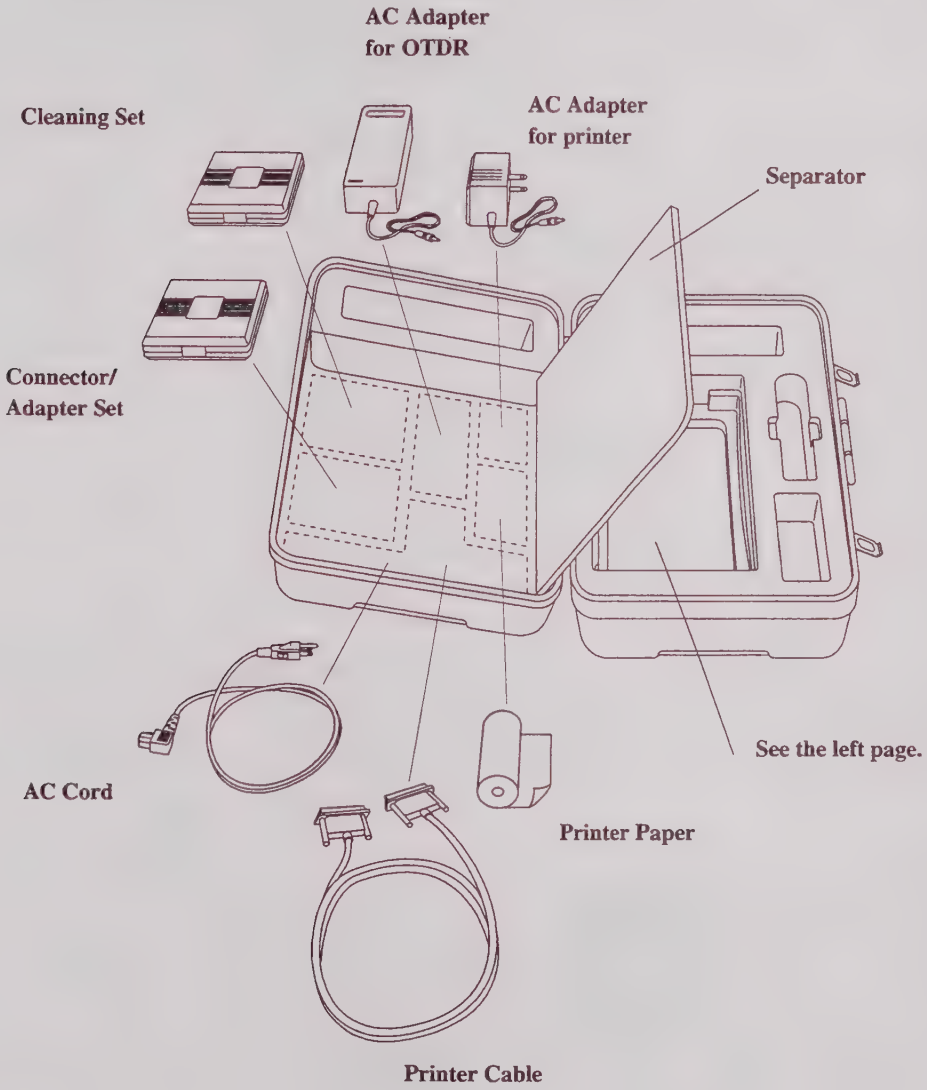
The soft case and the hard case are available for the OTDR. The following two figures show how the related equipment is packed in the hard case. See 2.15 for the soft case.

Packing of the Hard Case

Hard case is option.

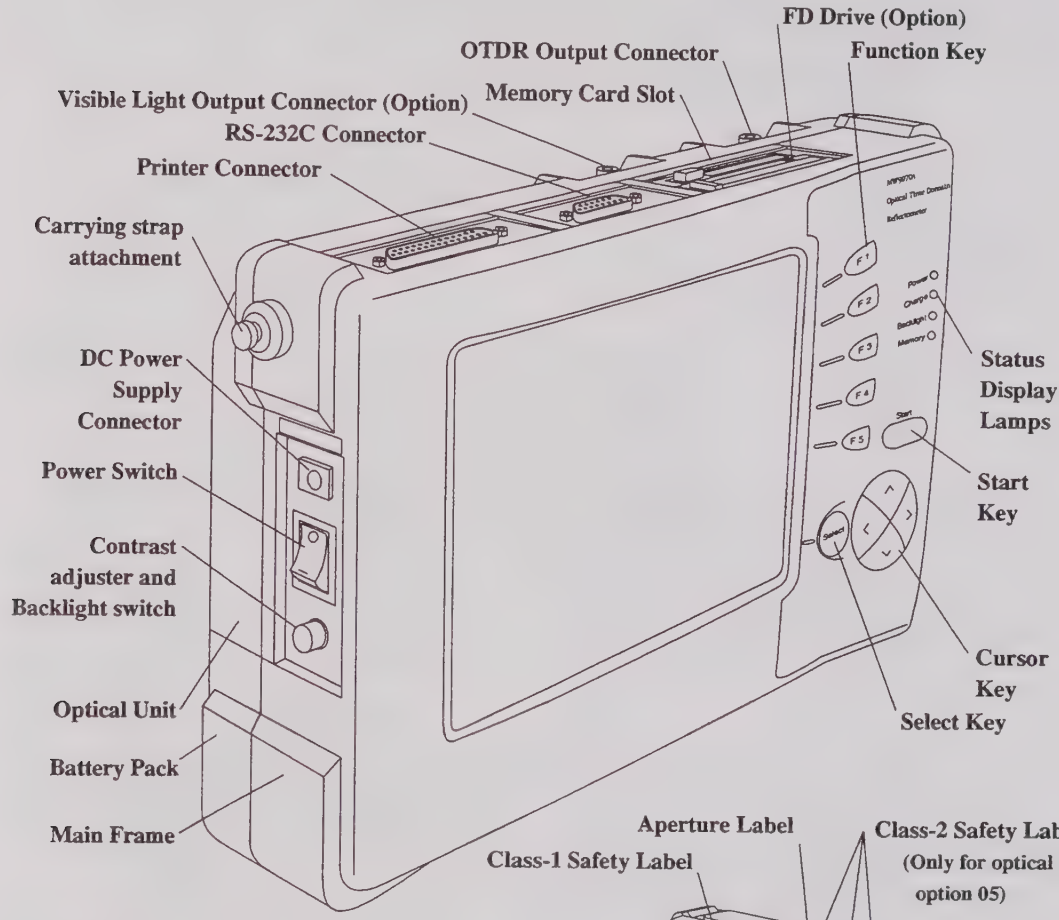


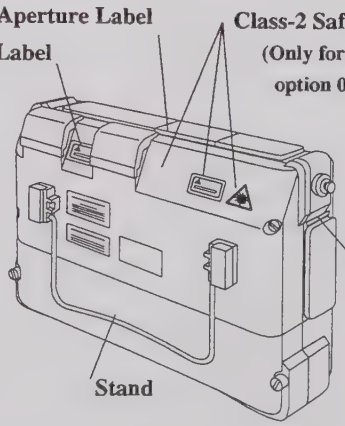
Packing of the Hard Case (Continued)



2.2 Names of Each Part

Check the names and functions of each part.The connector and switch protective covers are not shown in the following diagram.



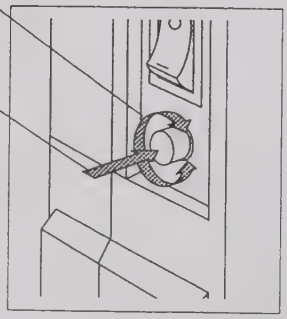


Contrast adjuster

The screen contrast is changed by turning this adjuster.

Backlight switch

This switch toggles the screen backlighting ON OFF each time it is pressed. Set it so that the screen display is easy to see. This cannot be switched off in the short period from power-on until the self test is completed.



See page v for details of the labels.

Status Display Lamp

Power

This lamp lights when the Power switch is set to ON and power is supplied to the OTDR.

If the lamp flashes, it indicates that the battery pack is discharged or that the AC adapter is not correctly inserted.

Charge

This lamp is lit when the battery pack is being charged from the AC adapter. It is also lit when the Power switch is off but power is supplied from the AC adapter.

Backlight

When this lamp is lit, the Backlight switch is on and the LCD is backlit.

Memory

This lamp is lit when the unit accesses to the memory card, or floppy disk. When the lamp is lit, it means that the memory card a floppy disk must not be removed from the main frame. The lamp is not lit when internal memory is being accessed.

Start Key

When this key is pressed, the laser light is output and measurement (sweeping) starts. Laser output is stopped by pressing the F5 (Stop) function key.

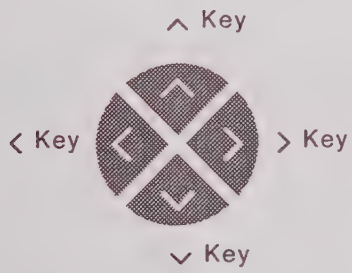
Select Key

This key switches the function of the Cursor key.

See the next page for further details.

Cursor Key

This circular key is divided into 4 parts: Up, Down, Left and Right. The function of each part is displayed on the bottom right of the screen. Refer to the next page for details about cards. The parts of the key are represented in this manual as follows:

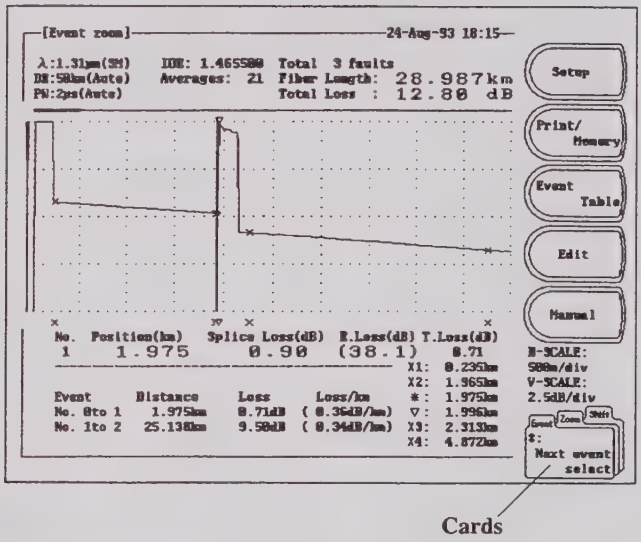


Function Keys

There are five function keys F1 to F5. The function of each key is displayed at the right side of the screen. These displays are called the function key labels. The operations that can be executed on the displayed screens can be found from the function key labels and from the cards explained on the next page.

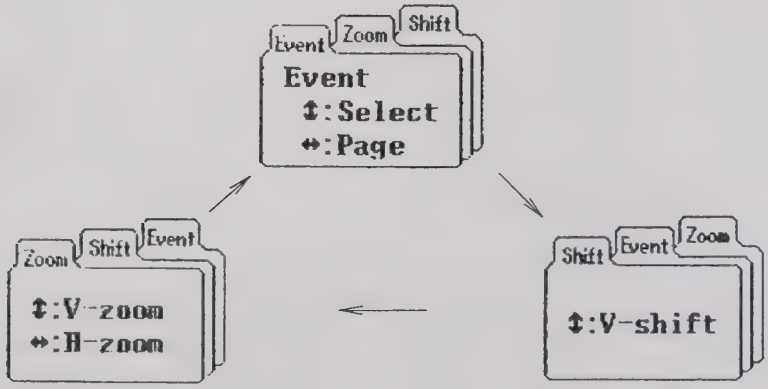
Cards

Cards explaining the operations that are possible on a particular screen are displayed at the bottom right of the screen. The card at the front of the pile explains the function of the Cursor key on the card. The cards at the back of the pile just display an index tab. The function of the Cursor key changes according to which card is at the front of the pile.



For example, in the diagram above, the Event card is at the front of the pile so the explanation on the card explains that the Cursor key is used to select events and pages; the ∧ and ∨ keys are used to select the event, and the > and < keys are used to turn over the pages of the Event Table.
To expand the waveform, press the [Select] key to bring the Zoom card to the front of the pile. The displays explains that the ∧ and ∨ keys expand and contract the display in the vertical direction, respectively, and that the > and < keys expand and contract it, respectively, in the horizontal direction.

Press the [Select] key once. The front card changes as shown below each time the Select button is pressed.



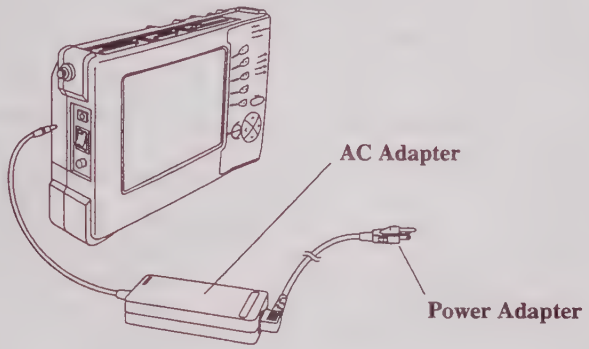
2.3 Charging Battery Pack

When the MZ5018A Ni-Cd Battery Pack is purchased, first, charge the battery pack for at least 14 hours. However, take care NOT to charge it for more than 20 hours because this may shorten the overall battery life. In addition, charge the battery within an ambient temperature range of 0° to 40°C.

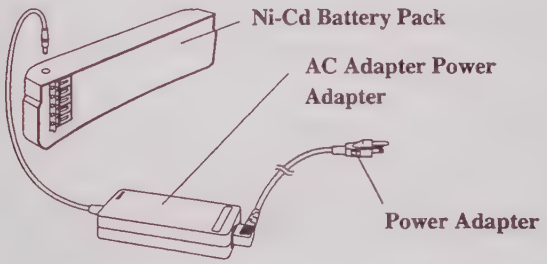
CAUTION

The MZ5020A Dry-Cell Battery Pack is not rechargeable. NEVER attempt to recharge it.

Connect the accessory AC adapter to the DC IN connector and then connect the adapter to an AC outlet. The Charge lamp is lit when power is supplied from the AC adapter to the OTDR whether or not the Power switch in on or off. (If the Dry Cell Battery is mounted, the battery is not charged.)



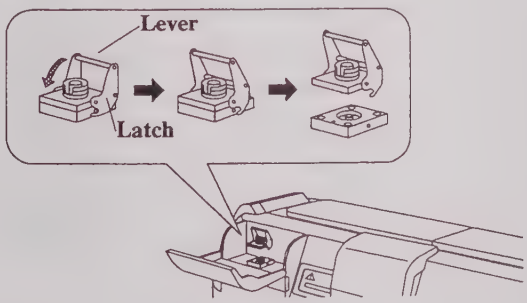
When the Ni-Cd battery pack is not mounted in the main frame, the battery pack can still be charged by connecting the AC adapter to it as shown in the following diagram.



2.4 Changing Optical Connector

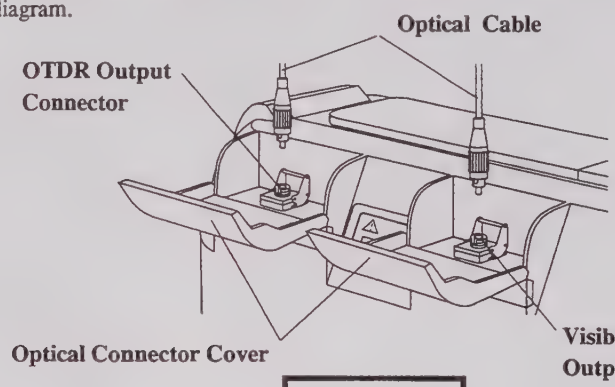
Use the following procedure to change the optical connector.

To change the optical connector, pull the lever forward until the hook is released and then lift off the optical connector. Refer to Appendix A for the various optical connectors that are available.



2.5 Connecting Optical Fiber Cable

Open the cover of the OTDR output connector or the visible light output connector on the main frame, and connect the optical cable as shown in the following diagram.



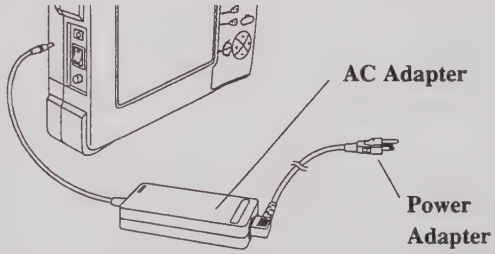
WARNING

NEVER look into the optical output connector on the main frame nor into the end of a cable connected to the optical output connector. If you do, the laser light may damage your eyes.

2.6 Connecting Power Supply

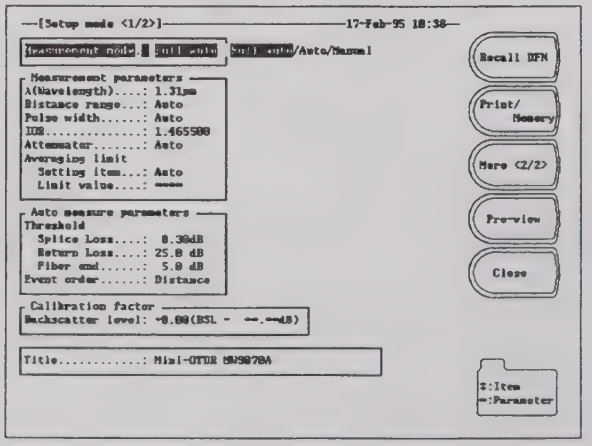
Connecting AC adapter

When using the AC adapter, connect it as shown in the following diagram.



2.7 Power-on

Setup screen 1 is displayed as shown below when the Power switch is set to ON and the self diagnosties is completed successfully. When the error message is displayed, see section 6.3 to take an action. If the setup screen 1 is not displayed, check the power supply and adjust the contrast knob. If the screen still does not appear, call Anritsu Corporation.



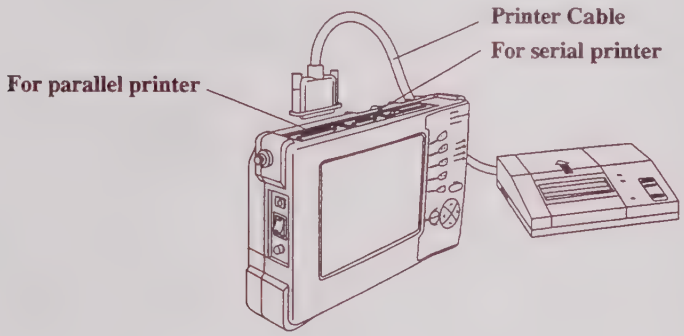
2.8 Adjusting Screen Contrast

See section 2.2.

2.9 Connecting Printer

1 At Setup screen 2, specify the printer to be connected, the print format, and printer interface to be used. For details, see paragraph 3.2.2 Print.

2 Connect the printer using the printer cable as follows. There are two different cable: for the parallel interface and the serial interface. Prepare a proper cable for your printer. Check that the printer has paper loaded.



3 Set the printer internal DIP-SW1 for the parallel interface printer, and set both DIP-SW1 and DIP-SW2 for the serial interface printer.

DIP-SW1

SW No.	Function	Setting
1	Interface	ON: Parallel / OFF: Serial
2	CR Code	OFF: Carriage Return
3	Print Mode	OFF: Condensed Printing (80 columns)
4	Character Set	ON: Ordinary Set
5	Zero Font	OFF: ø
6	Language Selection	OFF:
7	Language Selection	ON: } US English
8	Language Selection	ON:

DIP-SW2

SW No.	Function	Setting
1	Data bit length	ON: 8 bits
2	Parity permission	OFF: With
3	Parity condition	OFF: Even
4	Boud rate	OFF:
5	Boud rate	OFF: } 9600 bps
6	Boud rate	OFF:

2.10 Using Memory Card

See Appendix A for the usable memory cards.

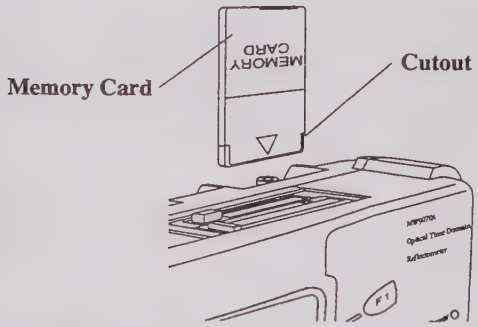
A new memory card must be formatted before a file can be saved on it. The card is formatted in the MS-DOS format.

Refer to section 4.5 (2) for details.

To write a file to the memory card, check that the write-protect switch is not set and insert the memory card into the card slot in the main frame. (For the write-protect setting, see the memory card manual.)

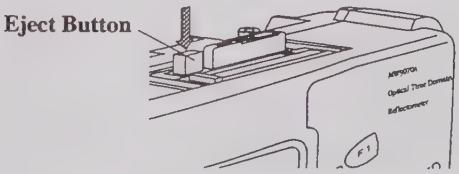
Inserting memory card

To prevent mis-insertion, the memory card has a cutout; insert it as shown in the diagram below.



Removing memory card

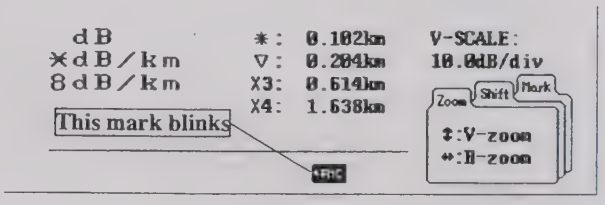
The memory card can be removed as shown below when the eject button is pressed.



Changing memory card battery

The memory card has a back-up battery. This must be changed when the voltage falls too low. The following alarm is displayed on the screen at this time and a buzzer sounds.

When this screen appears, change the battery in the memory card by referring to the memory card manual.



2.11 Using Floppy Disk (Option)

A new floppy disk must be formatted before a file can be saved on it. The floppy disk format is MS-DOS.

Refer to section 4.5(2) for details.

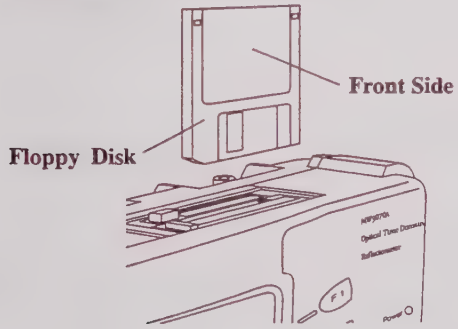
Both double-density (2DD) and high-density (2HD) disks can be used. The data capacity of each floppy disk is as follows:

2DD	2HD
720 KB	1.44 MB

To save a file to a floppy disk, check that the disk write-protect slot is closed and insert the disk into the disk drive in the main unit.

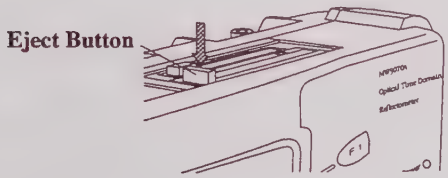
Inserting floppy disk

Insert the disk as shown in the diagram below.



Ejecting floppy disk

Eject the floppy disk as shown below by pressing the eject button.



CAUTION

1. Only operate the floppy disk drive with the screen of the main frame horizontal, or when the stand is set to incline the screen from the vertical position.

2. The floppy disk drive operating temperature is 5 to 40°C.

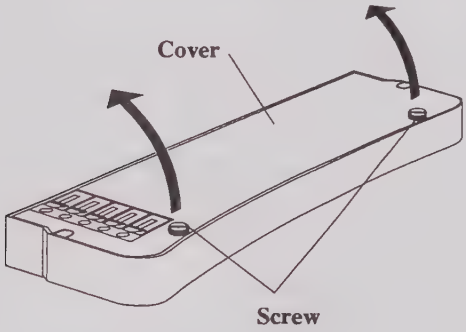
3. Eject a floppy disk from the disk drive before moving the equipment.

2.12 Inserting Dry-Cell Batteries

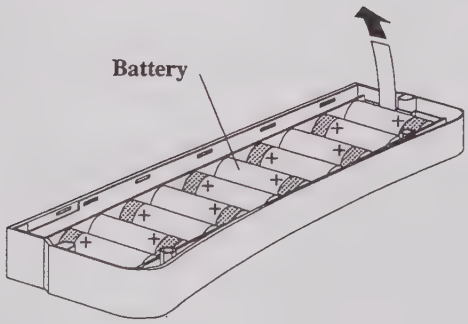
Use 10 dry-cell batteries (C or Baby size) in the Dry-Cell Battery Pack. Use Alkaline Dry Cell Battery (LR14) or Manganese Dry Cell Battery (R14). Never mix old and new batteries.

See Appendix A (3) for the operation time of alkaline dry-cell battery and manganese dry cell battery.

Remove the two screws to open the cover.



Insert the batteries correctly.



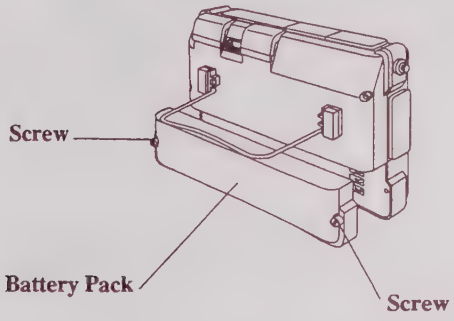
CAUTION

1. **Insert the batteries with the correct polarity, or the electrolyte may leak or the battery may explode.**
2. **Never mix new and old batteries, or different types of batteries.**
3. **Be sure not to short the battery pack contacts when it is detached.**
4. **Do not dispose of batteries by incineration.**

2.13 Fitting Battery Pack

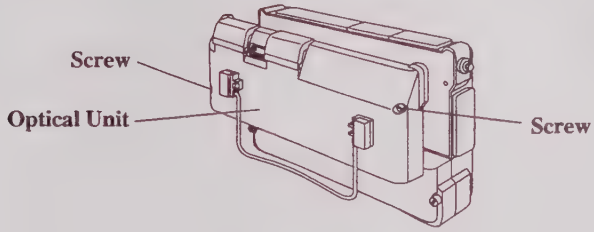
Raise the stand as shown below by pressing on the inside of both arms. Fit the battery pack to the main unit and tighten the two screws with a coin or screwdriver.

Tighten the two mounting screws shown in the following diagram to install the battery pack in the main frame.



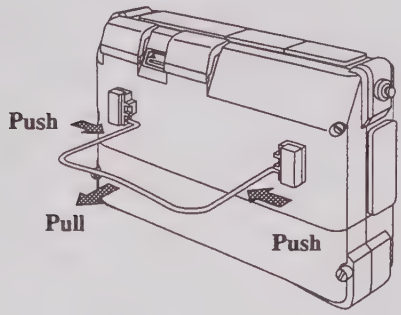
2.14 Installing Optical Unit

Install the optical unit in the main frame as shown in the following diagram and tighten the two screws with a screwdriver.

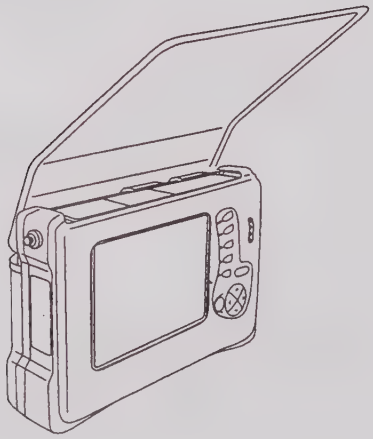


2.15 Fitting Soft Case

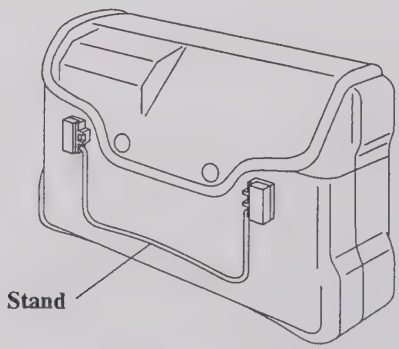
To put the OTDR in the optional soft case, remove the stand mounted on the rear panel of the OTDR as shown in the diagram below.



Put the unit in the soft case.

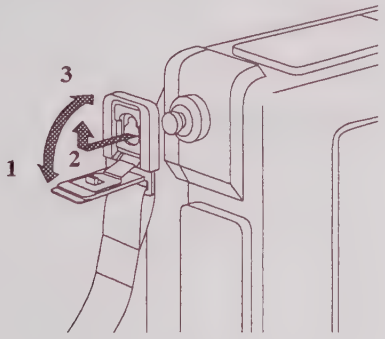


The removed stand fits in the soft case as shown below.

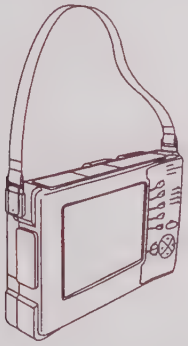


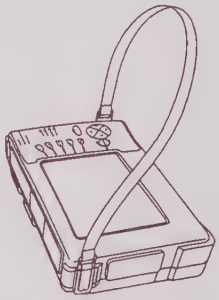
2.16 Fitting Band

The OTDR band can be removed as shown in the following diagram.



The band can be fitted so that the OTDR can be operated while slung from the shoulder or from the neck.





2.17 RS-232C Interface

The MW9070A has an RS-232C interface for connecting a computer to process the waveform data and for printing.
Refer to MW9070A Serial Interface Manual (M-W0751AW) for details of remote controlling command.

2.18 Precautions

Connector Cover
The interface connector has a protective cover. Only remove the protective cover to fit a cable to the connector.

Condensation
When carrying the OTDR from a low-temperature environment into a warm room, etc., there is a danger of condensation forming in the OTDR. In this case, allow the OTDR to dry out thoroughly before switching the power on.

Extreme Temperatures in Vehicles
There is a danger of a fault occurring if the OTDR is exposed to very extreme temperatures (-20°C or +60°C) when left in a vehicle. Do not expose the OTDR to extreme temperatures.

Safety

Grounding
When the AC adapter is used, connect the ground line to earth. The OTDR may be damaged if the AC adapter is not grounded or there may be a danger of an electric shock.

Do not use any AC adapter other than the supplied accessory adapter. If another adapter is used, it may not meet the required specifications and the OTDR may be damaged.

This section explains the items that can be set at the Setup screens and the setting methods. It also explains the preview function for checking the settings, how to save the settings as a file, how to recall the saved settings file, and how to print the settings.

3.1 Settings 26

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3.2.1 Setup Screen 1 28
3.2.2 Setup Screen 2 33
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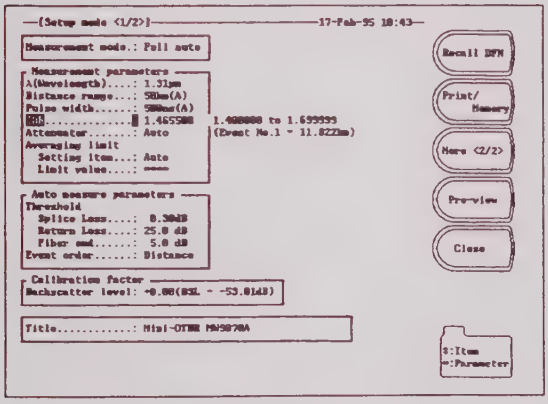
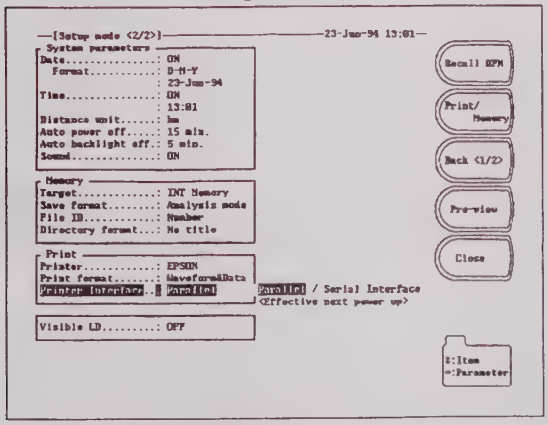


Setup Screen 1



Setup Screen 2

The Setup screens are used to change the OTDR measurement conditions. They are composed of Setup screen 1 (Setup mode <1/2>) and Setup screen 2 (Setup mode <2/2>). Setup screen 1 is always displayed when the OTDR is switched on. In addition, the measurement conditions can be changed by displaying the Setup screens by pressing the F1 (Setup) key in any measurement mode.

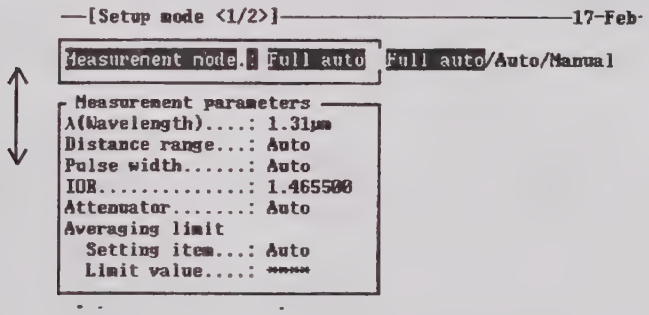
The measurement conditions are saved in the OTDR internal memory when the OTDR is turned off and the same conditions are read from memory when the power is next turned on. Furthermore, when the measurement conditions have been pre-saved as a DFN (DeFiNition file), the standard measurement conditions can be recalled simply by reading the DFN file even after various settings have been changed.

Note: The DFN file cannot be saved in other than the OTDR internal memory.

3.1 Settings

Changing Settings (Items)

The setting items are moved up and down by pressing the ∧ and ∨ keys.



Changing Measurement Conditions (Parameters)

Some measurement parameters are selected from a displayed list, and others are input any value.

Selecting Parameter

The reverse-displayed parameter to the right of the : symbol is the currently-set parameter; this can be changed by selecting another parameter using the < and > keys.

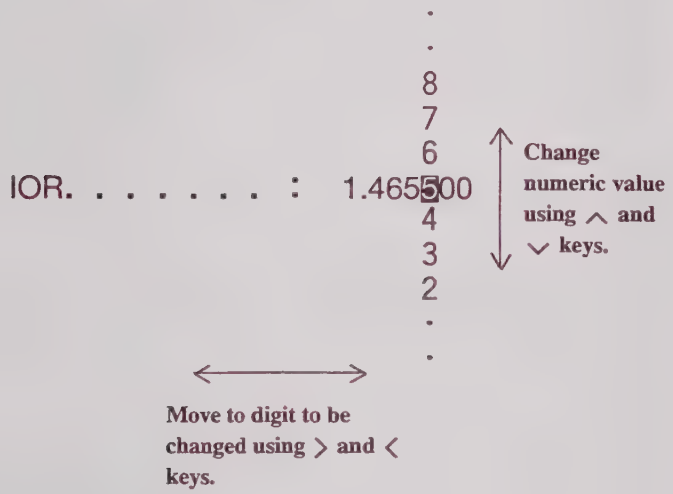
Inputting Value

Numeric values displayed to the right of the specified item can be changed as described below. The IOR, threshold value, date and time can be input in a similar manner.

1 Move the cursor to the numeric value to be changed using the > key. To return, use the < key.

2 Change the numeric value using the ∧ and ∨ keys.

3 Repeat steps 1 and 2 to move to the other digits to be changed and then return the cursor to the : symbol using the < key.



Note:

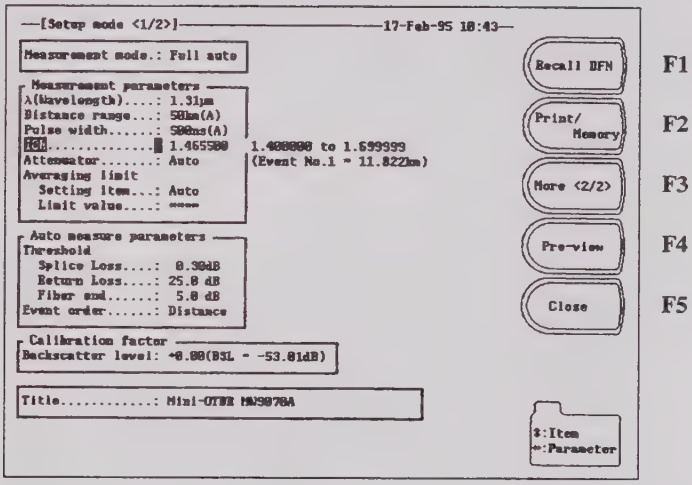
1. The method for inputting a title at the Title line on the lower part of Setup screen 1 is different from the above method. It is the same as the method used for inputting a title when saving and printing a file.

2. When the setup contents are changed, sometimes, the waveform is cleared, or a new waveform is computed and overwritten.

3.2 Explanation of Setup Screens

This section explains each parameter in the Setup screens shown below. The settings at factory shipment are explained in section 3.2.3.

3.2.1 Setup Screen 1



Measurement mode

Measurement mode (Full Auto/Auto/Manual)

The measurement mode can be set to either Full Auto, Auto or Manual.

Full Auto mode

Measurement is performed in about 3 minutes and any fault point on the fiber that exceeds the values set at Auto measure parameters is displayed as an event. The optimum values for the Distance range and Pulse width are set automatically.

Auto mode

This is the same as the Full Auto mode except that the Distance range and Pulse width set at the Setup menu are used. (It is exactly the same when the Distance range and Pulse width are set to Auto.)

Manual mode

The loss and distance of any part of the fiber can be measured by using the markers. The number of averaging times is set at Manual measure parameters to obtain a waveform with less noise. The Distance range and Pulse width can also be set to the optimum values in this mode by setting the parameters to Auto.

Measurement parameters

Measurement parameters

The measurement parameters are common to all of the Full Auto, Auto and Manual modes. The Distance range and Pulse width parameters are skipped when the Full Auto mode is set.

λ Wavelength (1.31/1.55 μm, 0.85/1.3 μm)

SM Fiber Unit: A wavelength of either 1.31 or 1.55 μm can be selected. (1.31 μm only for the MW0970A and MW0970B unit)

GI Fiber Unit: A wavelength of either 0.85 or 1.3 μm can be selected. (0.85 μm only for the MW0973J unit)

Distance range (AUTO/5/10/25/50/100/200 km)

The displayed Distance Range options depend on the mounted optical unit and Pulse Width set at the Setup screen.

When the Distance range is set to Auto and the [Start] key is pressed, the optimumDistance range is found automatically and displayed on the screen. If the length of the optical cable is known, input a value that is slightly larger than the known length. If the input length is too long, the measurement time will increase. If a shorter length is input, the measurement will not be correct.

Pulse width
(AUTO/20/50/100/500/1000/2000/4000/10000 ns)

The displayed Pulse Width options depend on the mounted optical unit and Distance Range set at the Setup screen.

When the Pulse width is set to Auto and the [Start] key is pressed, the optimum Pulse width is found automatically and displayed on the screen. Although the resolution is increased by setting a shorter Pulse width, since the power is decreased, in longer cables, the noise component increases progressively.

The maximum settable pulse width changes according to the distance range.

The cable loss (D) in dB can be calculated with the cable length (L) in km as follows (When SM fiber is used):

D = 0.35 x L (at 1.31 μm) D = 0.25 x L (at 1.55 μm)

Use the following figures as a guide to set the pulse width.

Wavelength: 1.31 μm

Cable loss (dB)	10	13	15.5	19.5	21	22.5
Pulse width (ns)	20	50	100	500	1000	2000

Wavelength: 1.55 μm

Cable loss (dB)	8	11	13.5	17.5	19	20.5
Pulse width (ns)	20	50	100	500	1000	2000

Index of Refraction (IOR) (1.400 000 to 1.699 999)

Set the IOR of the cable to be measured. If the IOR is not known, use the distance value displayed on the right, indicating the distance to the currently-selected marker or event. Adjust the IOR so the displayed distance to the marker or event is correct.

Attenuator

To measure longer distances, the pulse width of the optical output should be wider. However, a wider pulse width can cause saturation of the near-end trace because of excessive reflection. The attenuator is inserted to prevent the saturation. The available attenuation values depend on the Pulse Width set at the Setup screen as listed below:

Pulse Width	Available attenuation Values
20 ns	AUTO/0.0/4.0/9.0/14.0 dB
50 ns	AUTO/0.0/4.0/9.0/14.0 dB
100 ns	AUTO/0.0/4.0/9.0/14.0 dB
500 ns	AUTO/0.0/4.0/8.0/13.0/18.0 dB
1000 ns	AUTO/0.0/4.0/8.0/13.0/18.0 dB
2000 ns	AUTO/0.0/4.0/8.0/13.0/18.0 dB
4000 ns	AUTO/0.0/3.0/6.5/10.5/15.5/20.5 dB
10000 ns	AUTO/0.0/3.0/6.5/10.5/15.5/20.5 dB

Averaging limit

Averaging Value

Setting Item (Auto/Number/Time)

This sets how the obtained data is averaged.

Auto

The averaging time or number is set automatically. When Full Auto is set at the Measurement mode, only Auto can be selected.

Time

The data obtained in a set time period is averaged.

Number

The data obtained over a set number of sweeps is averaged.

Limit value

This sets the number of seconds for averaging, or the number of times. This cannot be set at the Full Auto of Measurement mode; * * * * is displayed to indicate it.

Auto measurement parameters

Full Auto mode and Auto mode parameters
These are the measurement parameters that are set when the Auto mode is set.

Threshold
This sets the thresholds for evaluating fault points.

Splice loss (0.01 to 9.0 dB)
Points with a loss greater than the set value are evaluated as faults (events).

Return loss (20 to 60 dB)
Points with a return loss less than the set value are evaluated as faults (events).

Fiber end (1 to 10 dB)
The point showing a loss greater than the value set here is evaluated as the fiber far end.

Event order (Distance/Level)
This sets the order in which events in the Event Table are displayed.

Distance
The events are displayed in order from the OTDR to the far end of the cable.

Level
The events are displayed in order from the event with the largest loss to the event with the smallest loss.

Calibration factor

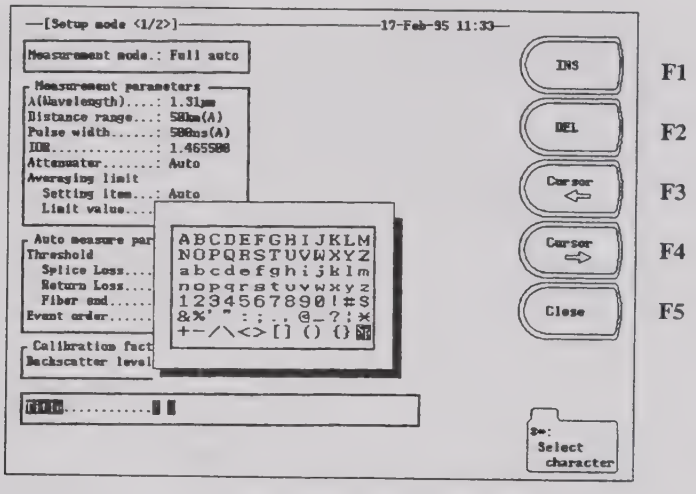
Backscatter level
This sets the calibration value for return loss. Usually, 0 is set, but set a calibration value when wanting to measure with very high precision.

See section 5.2 for the setting method.

Title

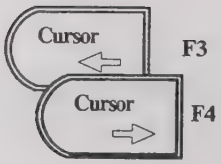
The title set here is displayed on the top of the screen displaying the waveform trace. Up to 32 characters can be displayed.

When this item is selected and the > is pressed, the following character-input window



Input Title Screen

Title: and the reverse display to its right are called the cursor; characters and spaces can be input and deleted at this position.



Inputting characters

All the characters that can be input are displayed in the rectangular box in the center of the screen. One of these characters is reverse-displayed. Move the reverse display up, down, left and right using the ∧, ∨, < and > keys respectively. When the reverse display is positioned at the character to be input, press the F4 (Cursor ⇨) key. The Title: field input cursor moves to the right each time a character is input. When the F3 (Cursor ⇦) key is pressed, the reverse-displayed character is input in the same manner as above, but the Title: field cursor moves to the left instead.

Inputting spaces

When the F1 (INS) key is pressed, one space is inserted in front of the character where the cursor is positioned.

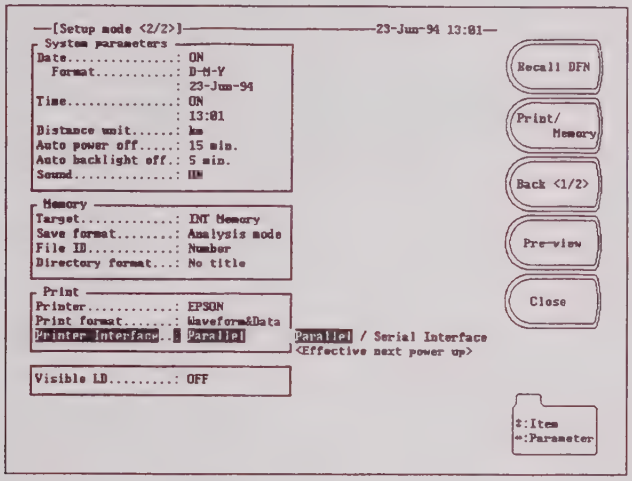
Deleting characters

When the F2 (DEL) key is pressed, the character where the cursor is positioned is deleted.

Confirming title

The title input is confirmed by pressing the F5 (Close) key, and the Setup screen is returned.

3.2.2 Setup Screen 2



System parameters

Date (ON/OFF)

ON: The date is displayed at the top right of the screen. The date is printed at printing.

OFF: The data is not displayed and is not printed.

Format (M-D-Y/D-M-Y/Y-M-D)

M-D-Y: The date is displayed in the order month, day and year.

D-M-Y: The date is displayed in the order day, month and year.

Y-M-D: The date is displayed in the order year, month and day.

Move the cursor to the current date item on the line displayed under Format and press the ∧ or ∨ keys to change the day, month or year.

Time (ON/OFF)

ON: The time is displayed at the top right of the screen. The time is printed at printing.

OFF: The time is not displayed, but is printed.

Move the cursor to the current time item on the line displayed under Time and press the ∧ or ∨ keys to change the hour or minute.

Distance units (kf/f/km/m/mi)

kf: kilofeet f: feet

km: kilometers m: meters

mi: mile

Auto power off (3/5/15/30/None)

The power is switched off automatically if a key or switch is not pressed during a set time interval (minutes). This time does not include averaging time or autosearching time. The function does not operate when None is set.

Auto backlight off (3/5/15/30/None)
The backlight is switched off automatically if a key or switch is not pressed during a set time interval (minutes). The function does not operate when None is set.

Sound (ON/OFF)
ON: The buzzer sounds when key or button is pressed, error message is dis played, or the battery pack is discharged. The length of the buzz varies as follows:

Key or button:	Short
Error message:	Quite longer
Battery:	Very long

OFF: The buzzer only sounds when the battery pack is discharged.

Memory

File ID (Number/Name)

Number:	File name is input as number.
Name:	File name is input as alphabetic name.

Target (INT Memory/memory card)
This specifies where to save and read the waveform data to and from.

INT Memory:	Main frame internal memory
Memory card:	Memory card inserted in slot

Save format (Print mode/Analysis mode)

Print mode:	The data is saved in a format that can only be printed. The data quantity is smaller so more waveforms can be saved. Waveforms saved in this mode cannot be searched for faults in newly set threshold conditions, or cannot be redrawn in newly set marker position.
Analysis mode:	Waveform saved in this mode can be analyzed or printed. They can be searched for faults in newly set threshold conditions, or can be analyzed with newly set marker position.

Directory Format

No. Title:	File titles not displayed and file list displayed quickly
Title:	File titles displayed in file list

Print

Printer (EPSON/HP/DPU-411/DPU-412)
This specifies the printer to be connected to the main frame.

EPSON: EPSON printers (printers that use the ESC sequence*)
HP: HP printers (printers that use the ESC sequence*)
DPU-411: Seiko printer (37.5 cps, 8 x 320 dot/line)
DPU-412: Seiko printer (80 cps, 16 x 640 dot/line)

Note: Some models of EPSON and HP printers that support the ESC sequence cannot be used.

Print format (Waveform & Data/Data)
Waveform & Data: The measurement results and waveform data are printed.

Data: Only the measurement results are printed.

Printer interface (Parallel/Serial)
This specifies the printer interface. This setting becomes valid after turning back the power on.

Parallel: The print data are output from the printer connector.
Serial: The print data are output from the RS-232C connector.

3.2.3 Settings at Factory Shipment

– The DFN file is set as follows at factory shipment.

Measurement mode	FULL AUTO
Measurement parameters	
λ (Wave Length)	1.31 µm
Distance range	AUTO
Pulse width	AUTO
IOR (Index of reflection)	1.465500 (at 1.31 µm)
	1.466100 (at 1.55 µm)
Attenuator	AUTO
Averaging limit	
Setting item	AUTO
Auto measure parameter	
Threshold	
Splice loss	0.30 dB
Returen loss	25.0 dB
Fiber end	5.0 dB
Event order	Distance
Calibration factor	
Backscatter level	0.00 dB
When the Measurement mode is set to the Manual	
Averaging limit	
Limit value	256 times, or 180 seconds
Mode	Splice mode
	LSA

– The unit is set as follows at factory shipment.

System parameters	
Date	ON
Format	D-M-Y
Time	ON
Distance unit	kf
Auto power off	15 minutes
Auto backlight off	5 minutes
Sound	ON
Memory	
Target	INT Memory
Save format	Print mode
File ID	Number
Directory Format	Title
Print	
Printer	DPU-411
Print format	Waveform & Data

3.2.4 Function Keys

Reads from DFN file
The measurement parameters stored in the DFN file are returned and set. Clears displayed waveform but coordinates remain displayed.

See section 3.3 (1) for reading the DFN file.

The following operations are possible at the screen displayed when this key is pressed.

Saveing to DFN file
The current measurement parameters are saved in the DFN file.

See section 3.3 (2) for saving to the DFN file.

Printing setup contents
The contents set at Setup screens 1 and 2 are edited and printed.

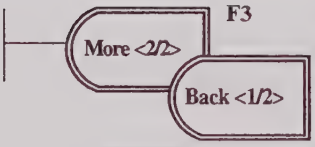
See section 3.3 (3) for printing the setup contents.

Reading saved waveform
Waveform data saved in the internal memory or a memory card is read.

See section 4.4.3. for details.

Operating file
Waveform data is erased, or the memory card is formatted.

See section 4.5 for details.



Moves to other Setup screen
Changes from Setup screen 1 to Setup screen 2 and vice versa.

Confirms settings
The preview function is started.

See section 3.4 for details.

Closes Setup screens
Returns to waveform screen.

3.3 Reading, Saving and Printing Setting Contents

When the power is turned off, the settings are saved in the main frame internal memory. At power-on, these saved settings are returned.

The settings can also be saved in a file. This file is called the DFN file. At factory shipment, each of the items in section 3.2.3 is written to this file. If this file is properly used, standard measurement parameters can be saved in it for recalling them after the various settings have been changed temporarily for any reason.

Note: The Title item in the Setup Screen 1 and all items in the Setup Screen 2 are not saved in the DFN file.

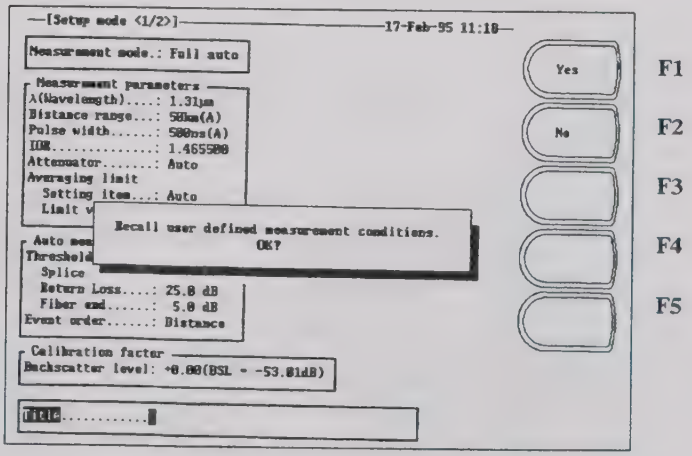
(1) Reading DFN file

If the measurement parameters have been saved in the DFN file, they can be recalled and set just by pressing one key after various settings have been changed temporarily.

1 Press F1 (Recall DFN) displayed at the Setup screens.

2 When the F1 (Yes) key displayed at the screen for confirmation is pressed, the DFN file is read and the main frame settings are changed to the settings saved in the DFN file.

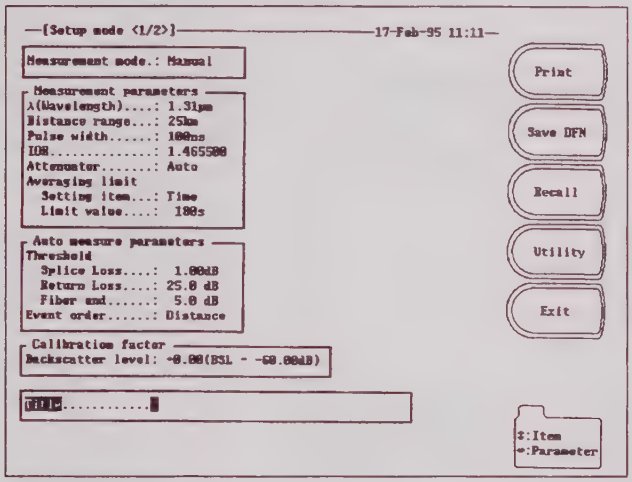
When F2 (No) is pressed, reading of the DFN file is canceled and the Setup screen is returned.



3 When the F5 (Exit) key is pressed, the Setup screen is returned.

(2) Saving to DFN file

1 When the F2 (Print/Memory) key displayed at the Setup menu is pressed, the following screen is displayed.

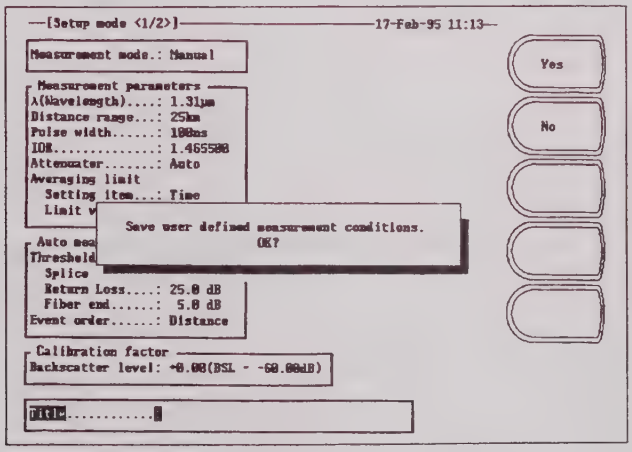


Setup Print/Memory Screen

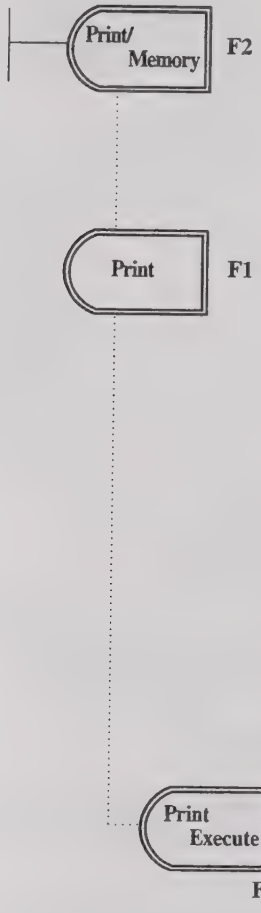
2 Press F2 (Save DFN) at this screen.

3 When the F1 (Yes) key displayed at the screen for confirmation is pressed, the settings are written to the DFN file in the internal memory and the Setup screen is returned.

When F2 (No) is pressed, the rewriting is stopped and the Setup screen is returned.

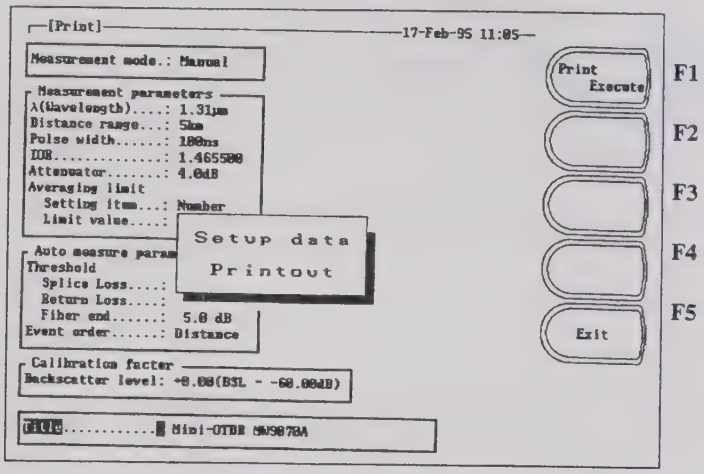


4 When the F5 (Exit) key is pressed, the Setup screen is returned.



(3) Printing setup contents

When the F1 (Print) key is pressed at the menu shown on the previous page, the following screen is displayed.



Setup Print Screen

See section 3.2.2 for setting the printer type.

See section 2.9 for connecting the printer.

When the F1 (Print Execute) key is pressed at this screen, the setup contents are edited and printed as follows.

```
COMMENT:
17-Feb-95 11:22

Measurement mode... Full auto                 Threshold
Wavelength......... 1310nm(SM)                  Splice loss.....  0.30dB
Distance range..... Auto                        Return loss..... 25.0 dB
Pulse width........ Auto                        Fiber end.......  5.0 dB
IOR................ 1.465500                   Event order........ Distance
Attenuator......... Auto                      Averaging limit
Backscatter level.. +0.00(BSL =  **.**dB)       Setting item..... Auto
                                                Limit value..... ****

Date display....... ON    Format:D-M-Y        Memory target..... INT Memory
Time display....... ON                        Save format....... Analysis mode
Distance unit...... km                        File ID........... Number
Auto power off..... None                      Directory format... No title
Auto backlight off. None                      Printer........... EPSON
Sound.............. ON                         Print format...... Waveform&Data
                                              Printer Interface.. Serial
```

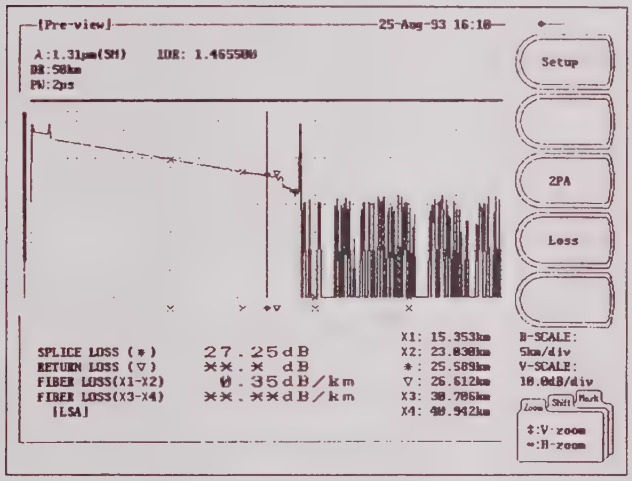
```
COMMENT:
17-Feb-95 11:23

Measurement mode... Full auto                 Threshold
Wavelength......... 1310nm(SM)                  Splice loss.....  0.30dB
Distance range..... Auto                        Return loss..... 25.0 dB
Pulse width........ Auto                        Fiber end.......  5.0 dB
IOR................ 1.465500                   Event order........ Distance
Attenuator......... Auto                      Averaging limit
Backscatter level.. +0.00(BSL =  **.**dB)       Setting item..... Auto
                                                Limit value..... ****

Date display....... ON    Format:D-M-Y        Memory target..... INT Memory
Time display....... ON                        Save format....... Analysis mode
Distance unit...... km                        File ID........... Number
Auto power off..... None                      Directory format... No title
Auto backlight off. None                      Printer........... EPSON
Sound.............. ON                         Print format...... Waveform&Data
                                              Printer Interface.. Parallel
```

Note: **When an error occurred in printing, turn off the power, clear the causes of error, and then turn on the power again.**

3.4 Preview

After setting the Setup screens and connecting the fiber cable, check the settings and connection with the preview function. The preview function updates the trace waveform about every 0.9 seconds to check the waveform while adjusting cable connections. The markers can be used in the same way as in the Full Auto, Auto and Manual modes.

1 Press F4 (Preview) at the Setup screen. Preview is started and the following screen is displayed.



Preview Screen

2 Press F4 (either Slice & Return Loss or Loss is displayed) to set the measurement purpose. The set measurement is displayed at the bottom left of the screen.

3 Press F3 (either LSA or 2PA is displayed) to set the linear approximation method.

4 Press F1 (Setup) to stop the preview function and return to the Setup screen.

To expand or move the waveform using the cursor keys, or to move the markers,

See section 4.2.

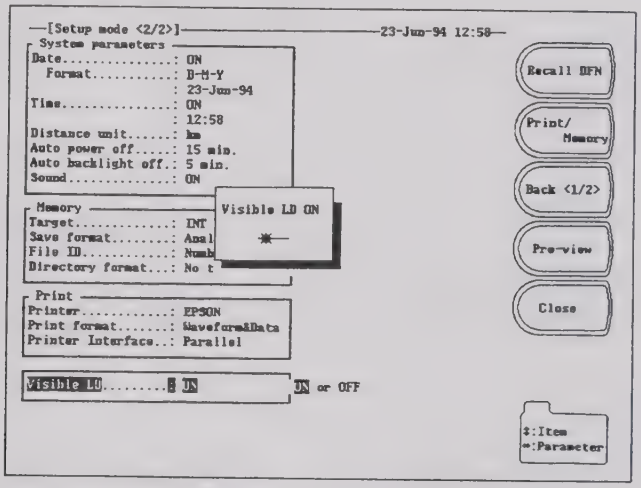
3.5 Visible LD Output (Option 05)

WARNING

NEVER look directly into the optical output connector of this instrument nor into the end of an optical cable connected to it, because there is a risk of injury if the laser light enters the eyes.

Procedures other than those specified herein may result in hazardous radiation exposure.

The following subwindow is displayed when the Visible LD of the Setup screen 2 is set to ON and the visible red light is output from the Visible LD optional connector.



Visible LD ON Screen

When the cursor is moved to the Visible LD item, it is always OFF. After setting the Visible LD to ON if the cursor is moved to any other item or any function key is pressed, the Visible LD setting returns to OFF.

Since this red light is visible, you can find a fault part of the optical fiber with leaked light. Note that the loss measurement and event detection cannot be performed using this visible light.

WARNING

NEVER look directly into the optical output connector of this instrument nor into the end of an optical cable connected to it, because there is a risk of injury if the laser light enters the eyes.

This section explains the operation methods for the principal uses of the OTDR. See Section 2 for the names of each part of the OTDR, and Section 3 for the setup methods.

Make sure you properly understand the precautions in section 2.16 regarding operation and storage.

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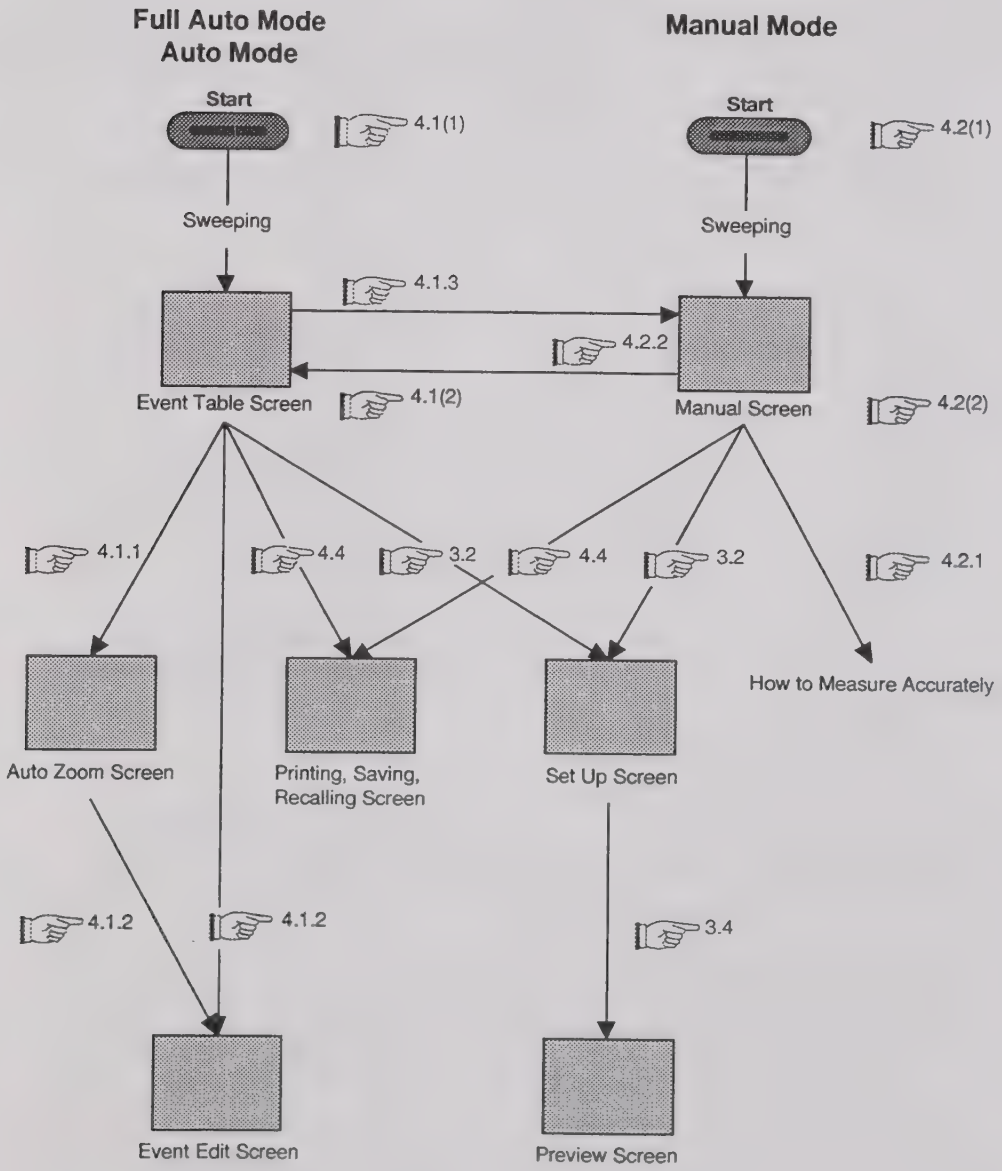
Operation Map



CAUTION

Don't connect this equipment to the circuit fiber line in operation. Light for the operation can cause an error in the measurement.

4.1 Auto Measurement

This automatically displays the position of faults (events) on the screen. Simultaneously, numeric data for each fault is displayed in table form on the lower part of the screen. This table is called the Event Table.

(1) Start

1 Set Measurement mode: at the Setup screen to Full Auto or Auto.

2 Set each of the Measurement parameters at the Setup screen to match the system to be measured.

3 Set the Auto measure parameters at the Setup screen to match the conditions for evaluating faults.

4 Press the [Start] key.

Auto measurement steps

When the [Start] key is pressed, the following three steps occur in sequence, the Event Table is displayed, and the screen displaying information about the faults is displayed. Press the F5 (Stop) key to stop Auto measurement.

1) Autosetting

In the Full Auto mode, the optimum values for the Distance range and Pulse width are found. In addition, if Distance range and Pulse width are set to Auto at the Setup screen in the Auto mode, this step finds these values.

2) Averaging

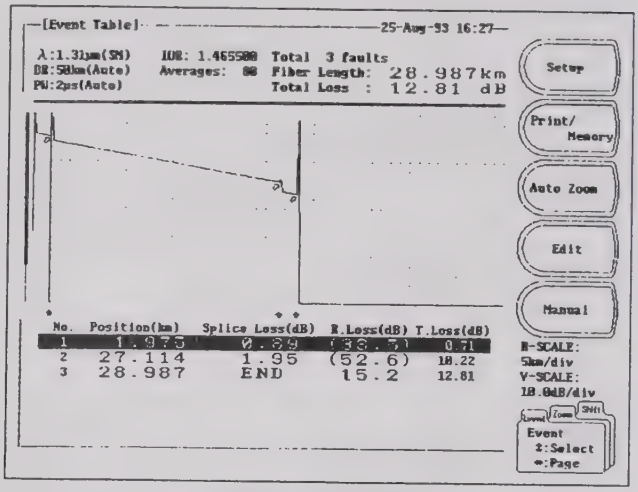
The optimum number of averaging times is assessed and executed.

3) Processing waveform and searching for faults

Phase 1: The waveform is normalized.
Phase 2: The waveform is smoothed.
Phase 3: Faults are searched for.

(2) Event Table screen

The following screen is displayed when searching for faults is completed.



Event Table Screen

The following items are displayed on this screen.

Measurement parameters

λ: Wavelength of light DR: Distance range PW: Pulse width
IOR: Index of Refraction Average: Number of averagings executed

Note: When Distance range and Pulse width are set to Auto at the Setup screen, the values chosen by the OTDR are displayed at DR and PW, respectively.

Search results

Total: Total number of faults Fiber length: Length of fiber
Total Loss: Total loss of fiber
Note: "OUT OF RANGE" is displayed at Fiber Length when the far end of the fiber cannot be detected.

Trace waveform

The trace waveform is displayed with the attenuation on the vertical scale and the distance on the horizontal scale. The scales of each axis are displayed at the bottom right of the screen. The ◇ symbol is displayed at fault points.

Event Table

The following values are displayed for each event.

No: The number of the fault counted from the left (near end)
Position: The distance of the fault from the OTDR
Splice Loss: The connection loss R. Loss: The return loss
T. Loss: The total loss

Note: The splice loss and return loss are assessed for faults exceeding the threshold values set at Setup screen 1. Brackets are attached to faults where one of the two items is within the threshold limits. However, when the measured value is not found for some reason such as the close proximity of a fault, * * . * is displayed. In addition, when the circuit is saturated by a large amount of reflected light, the measured value is prefixed by < .

Calls Setup screen
The measurement parameters can be changed at the setup screen.

See section 3.2.1.

Prints/saves/recalls

For details, see section 4.4.

Enlarges specific event

For details, see section 4.1.1.

Edits event

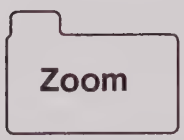
For details, see section 4.1.2.

Manual operation
This is used at Manual measurement for data collected in the Auto mode, to display the Manual screen and to make the same types of measurements as the manual measurement using markers.
The Event Table can be returned by pressing it again.

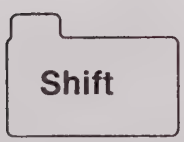
For details, see section 4.2. (2)

Selecting Event
To zoom and display a specific event, first press the [Select] key to bring the Event card displayed at the bottom right of the Event Table screen to the front of the pile. Change the selected event by moving the cursor up and down with the ∨ and ∧ keys.

When the last line in the Event Table under Splice Loss is not END, the next page can be displayed by pressing the > key. Moreover, when Event No. column does not start from 1, the previous page can be displayed by pressing the < key.



Zooming/Compressing to Any Magnification
When the [Select] key is pressed to bring the Zoom card to the front of the card pile, the vertical scale can be changed by pressing the ∨ and ∧ keys, and the horizontal scale can be changed by pressing the > and < keys to enlarge or compress the displayed waveform.

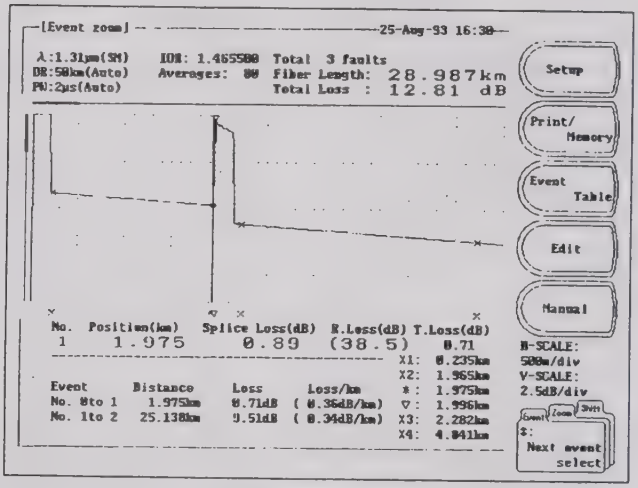


Shifting Waveform
When the [Select] key is pressed to bring the Shift card to the front of the card pile, the waveform can be shifted up, down, left and right by pressing the cursor keys. The waveform is shifted slightly each time the cursor key is pressed; it shifts continuously if the key is pressed and held.

4.1.1 Zooming to Specific Event

When the F3 (Auto Zoom) key is pressed at the Event Table screen, the selected event is centered on the screen and the waveform size is zoomed automatically so that all the markers are displayed on the screen. The six markers appear as shown in the following screen.

The zoomed waveform can be magnified, compressed and shifted using the cursor keys.



Auto Zoom Screen

To return to the Event Table screen

To return to the Event Table screen, press the F3 (Event Table) key.

To edit the event

To edit the event, press the F4 (Edit) key.

See section 4.1.2.

To fetch the Manual screen

To fetch the Manual screen, press F5 (Manual); the manual screen is fetched and the markers can be set for each type of measurement.

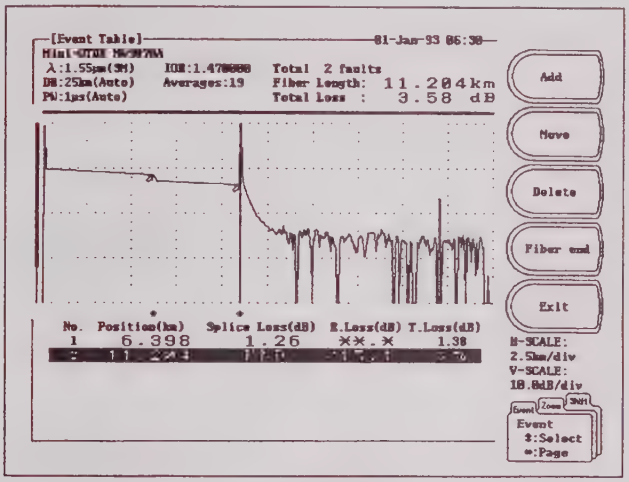
Other Function keys

The F1 and F2 keys, and the cursor keys have the same functions at this screen as at the Event Table screen.

4.1.2 Editing Events

The waveform is edited when wanting to save data about splices that are not faults in the Event Table, and when wanting to delete points mis-evaluated as faults because of noise. Also, a point which is not the physical for end, can be registered as a logical for end.

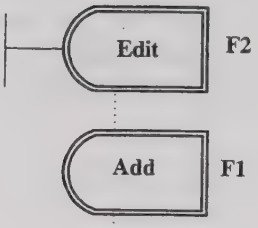
When F4 (Edit) key in the Event Table screen is pressed, the following Event Edit screen is displayed.



Event Edit Screen

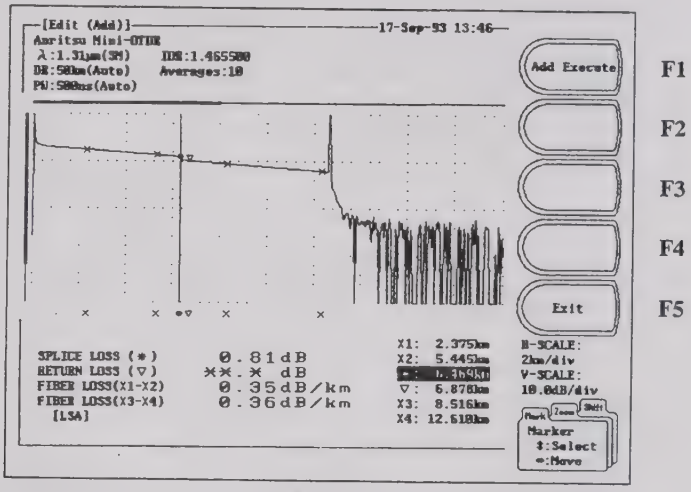
Exit

Press the F5 (Exit) key to return to the original screen.



Adding Events

When the F1 (Add) key is pressed at the Event Edit screen, the ✳ and ▽ markers are displayed along with two × markers on each side of these markers as shown in the screen below.



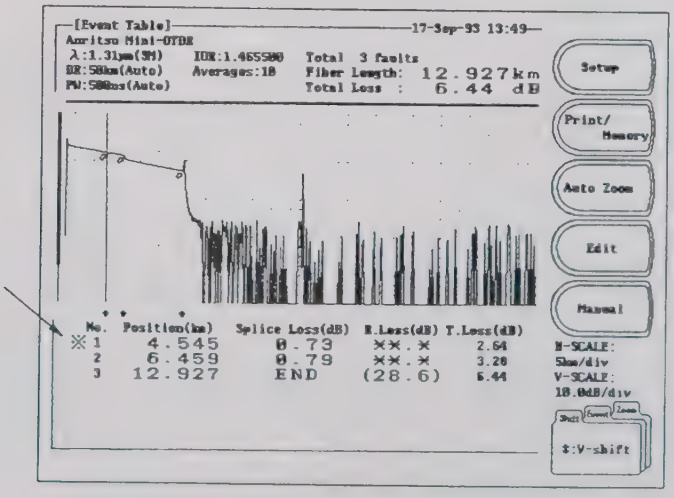
Add Screen

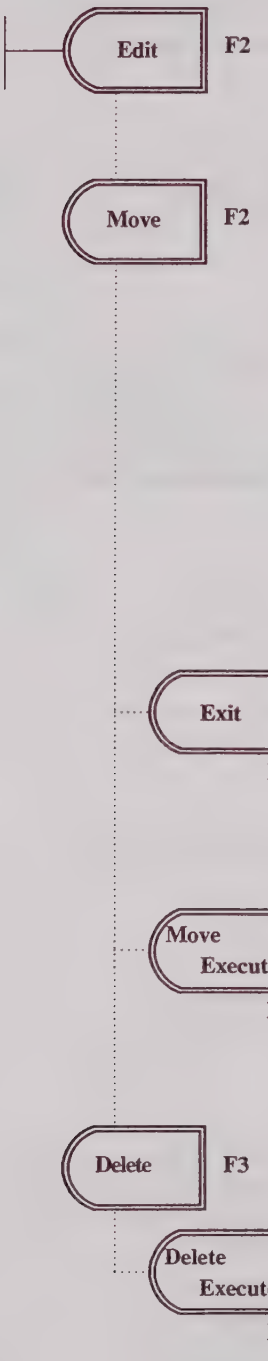
When an event was selected at the previous screen before the Add screen, the ✳ marker is positioned at that event; when an event was not selected at the previous screen, the ✳ marker is positioned at the screen center.

Press [F5] (Exit) to stop addition.

When the ✳ marker is moved to any position with the cursor keys and the F1 (Add Execute) key is pressed, the new event is added to the waveform and the Event Table Screen is returned.

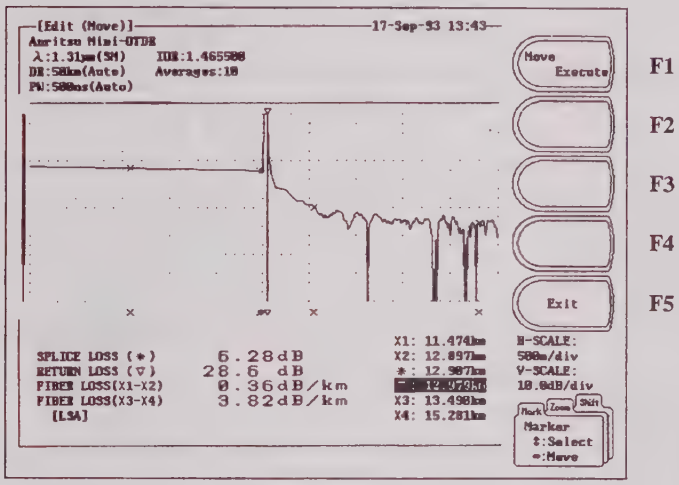
A ※ symbol is appended to the event added to the Event Table this time so that the changed event can be recognized.





Moving Events and Markers

When an event to be corrected is selected at the Event Edit screen with the cursor keys and the F2 (Move) key is pressed, the zoomed waveform is displayed with that event at the screen center. Six markers are also displayed on this screen.



Move Screen

Press [F5] (Exit) to stop movement.

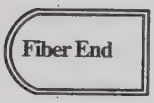
Select the marker to be moved with the ∨ and ∧ keys. The position of the selected marker can be moved with the < and > keys. When moving the ✳ marker, the event itself is also moved.

When the F1 (Move Execute) key is pressed after moving the marker, the event point is moved. The Event Table screen is returned and the added event is displayed at the head of the table with the ※ symbol appended so that the changed event can be recognized easily.

Deleting Event

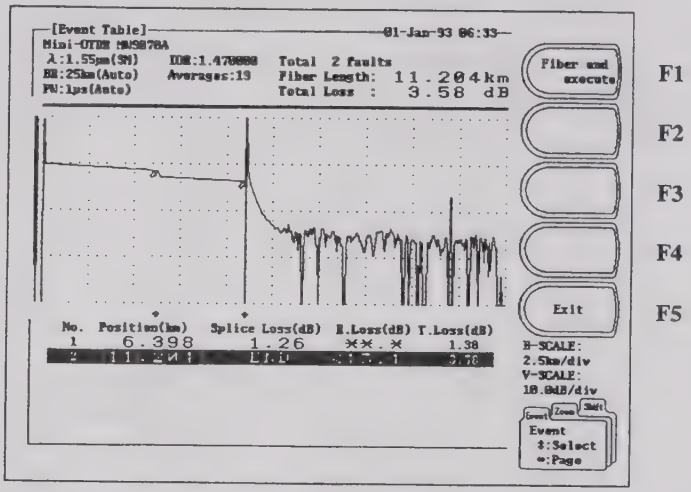
When the event to be deleted is selected with the cursor keys at the Event Edit screen and the F3 (Delete) key is pressed, the selected event is deleted.

Confirm the event to be deleted with the zoom screen and then press [F1] (Delete) to delete the event.



Setting fiber end

Any event can be regarded as fiber end. Select any event to be the fiber end in the Event Edit Screen, and then press the F4(Fiber end) key, and the following screen is displayed.



Setting Fiber End

When the F1(Fiber end) key is pressed, a currently selected event is registered as the fiber end. All events far from the event are deleted.

When the F5(Exit) key is pressed, the event Edit Screen is returned.

4.1.3 Moving to Manual Screen

When the F5 (Manual) key is pressed at the Event Table screen, the Manual screen is displayed for using data collected in the Auto mode to make various manual measurements with the same markers. When the F5 (Event Table) key is pressed in it, the Event Table screen is returned.

For further details, see section 4.2 (2).

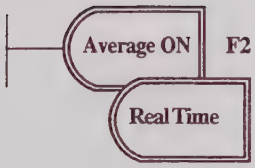
4.2 Manual Measurements

(1) Start

1 Set Measurement mode: at the Setup screen to Manual.

2 Set Measurement parameters at the Setup screen to match them to the system to be measured.

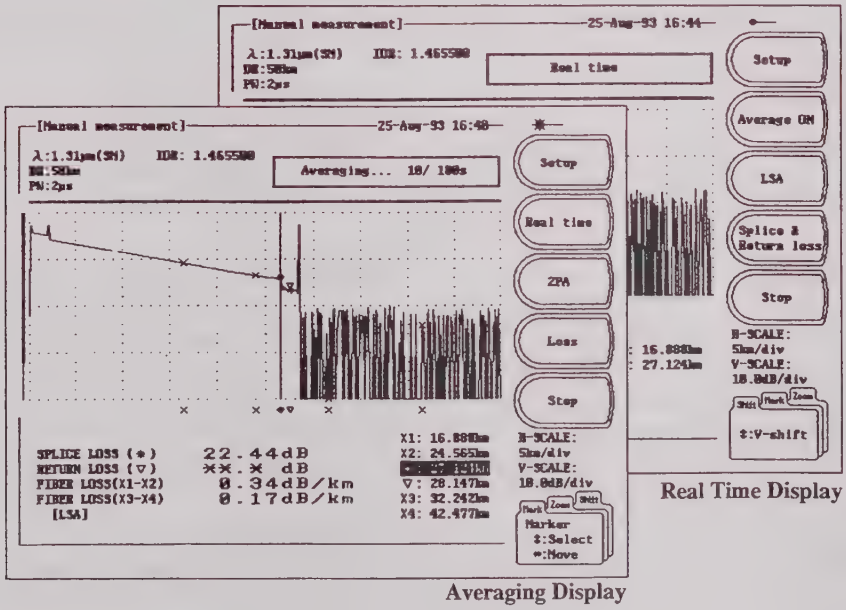
3 Set the averaging method at the Setup screen with Manual measure parameters.



4 Press the [Start] key. Measurement (sweeping) starts. The waveform shown in the Averaging display below is displayed on the screen and the measurement is repeated so the noise component is gradually reduced. When the F2 (Real Time) key is pressed, averaging is stopped and the waveform trace changes to the real-time display at each sweep. The averaging display is returned when the F2 (Average ON) key is pressed.

5 At the Averaging display, when the set number of averagings has been completed or the averaging time has elapsed, the Manual screen shown on the next page is displayed. When the F5 (Stop) key is pressed when a sufficiently good waveform has been obtained during averaging, the Manual screen is displayed immediately. At the real-time display, the Manual screen is not displayed until the F5 (Stop) key is pressed.

Note: During averaging, the current number of averagings or the elapsed time, as well as the set values are displayed at the top right of the screen.



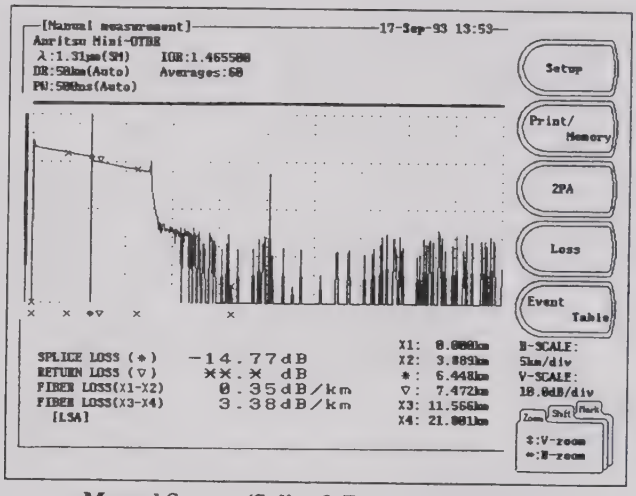
Real Time Display

Averaging Display

(2) Manual Screen

Splice & Return Loss Display

When the sweeping is finished, the following screen is displayed. This screen is also displayed when the F4 (Splice & Return Loss) key is pressed at the Loss Display screen.



Manual Screen (Splice & Return Loss Display)

Six markers as well as the splice loss measurement results are displayed on this screen. The following additional items are also displayed.

Measurement Parameters

λ: Wavelength of light DR: Distance range PW: Pulse width
IOR: Index of Refraction

Note: When the Distance range and Pulse width are set to Auto at the Setup screen, the values chosen by the OTDR are displayed at DR and PW, respectively.

Trace Waveform

The trace waveform is displayed with the attenuation on the vertical scale and the distance on the horizontal scale. The scales of each axis are displayed at the bottom right of the screen.

Measurement Results

Splice Loss (✳) : Splice loss at ✳ point
Return Loss (▽) : Return loss at ▽ point
Fiber Loss (×1 - ×2): Loss per unit distance between ×1 and ×2 points
Fiber Loss (×3 - ×4): Loss per unit distance between ×3 and ×4 points

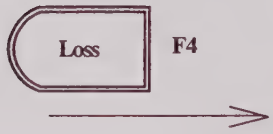
Note: ✳✳.✳ is displayed if measurement is impossible for any reason.When the circuit is saturated by a large amount of reflected light, the measured value is prefixed by <.

Marker Positions

The distance from the main-frame optical connector to each marker is displayed.

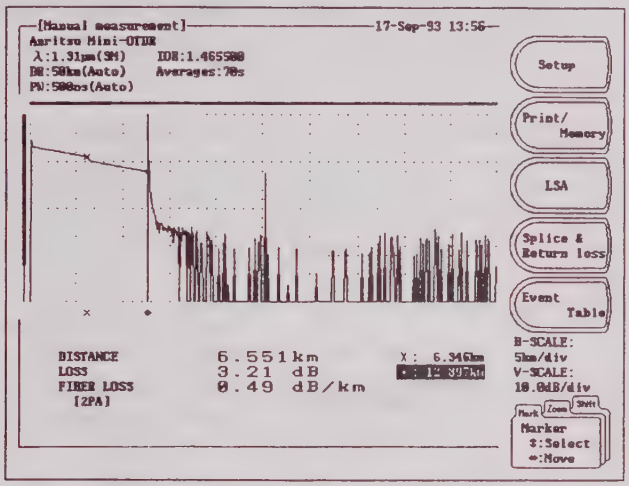
Linear Approximation Method

LSA or 2PA is displayed. LSA is displayed in the above diagram.



Loss Display

When the F4 (Loss) key is pressed at the Splice & Return Loss Display screen, the following Loss Display screen is displayed.



Manual Screen (Loss Display)

Two markers are displayed on this screen along with the loss between them.

Measurement Parameters

λ: Wavelength of light DR: Distance range PW: Pulse width
IOR: Index of Refraction

Note: When the Distance range and Pulse width are set to Auto at the Setup screen, the values chosen by the OTDR are displayed at DR and PW, respectively.

Trace Waveform

The trace waveform is displayed with the attenuation on the vertical scale and the distance on the horizontal scale.The scales of each axis are displayed at the bottom right of the screen.

Measurement Results

Distance:	Distance between two markers
Loss:	Loss between two markers
Fiber Loss:	Loss per unit distance

Note: ＊＊.＊ is displayed if measurement is impossible for any reason. When the circuit is saturated by a large amount of reflected light, the measured value is prefixed by <.

Marker Positions

The distance from the main-frame optical connector to each marker is displayed.

Linear Approximation Method

LSA or 2PA is displayed. 2PA is displayed in the above diagram.

F1

Setup Screen

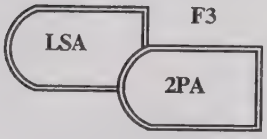
The measurement parameters can be changed at the Setup screen.

For details see Section 3.

F2

Printing, Saving, Recalling

For details see section 4.4 .

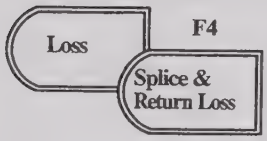


F3

Selecting Linear Approximation Method

The LSA and 2PA linear approximation methods are toggled each time this key is pressed. The selected method is displayed at the bottom left of the screen.

For details see section 1.6 .



F4

Switching Splice & Return Loss and Loss Displays

The Splice & Return Loss and Loss displays are toggled each time this key is pressed. Six markers are displayed on the Splice & Return Loss display and two markers are displayed in the Loss display.

F5

Searching for Faults

When the F5 (Event Table) key is pressed, the Event Table screen is displayed using the data collected in the Manual mode. The event markers can be displayed at the faults in the same way as at Auto measurement. When the F5 (Manual) key is pressed in it, the Manual screen is returned.

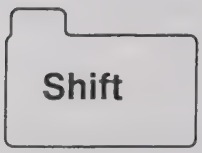
For details, see section 4.1 (2).

Shifting Markers

When the [Select] key is pressed to bring the Mark card to the front of the card pile, a marker can be selected with the ∨ and ∧ keys. The selected marker is moved with the > and < keys. The marker shifts continuously when the key is pressed and held.

Zooming/Compressing to Any Magnification

When the [Select] key is pressed to bring the Zoom card to the front of the card pile, the vertical scale can be changed by pressing the ∨ and ∧ keys, and the horizontal scale can be changed by pressing the > and < keys to magnify or compress the displayed waveform.



Shifting Waveform

When the [Select] key is pressed to bring the Shift card to the front of the card pile, the waveform can be shifted up, down, left and right by pressing the cursor keys. The waveform is shifted slightly each time the cursor key is pressed; it shifts continuously if the key is pressed and held.

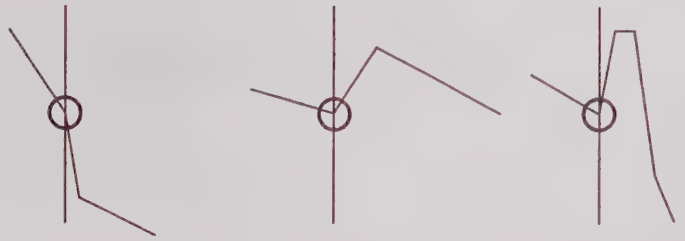
Note: Measurement such as loss at set markers and the Splice & Return-Loss/ Loss display switching can still be performed during averaging.

4.2.1 How to Measure Accurately

(1) Setting marker

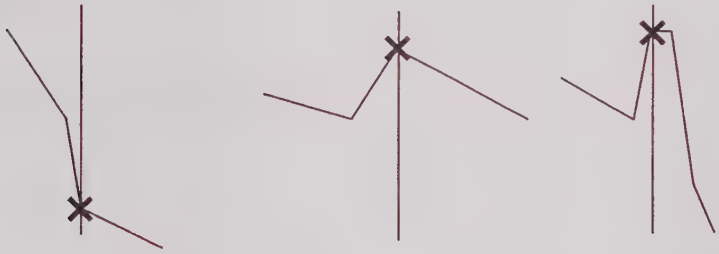
To measure the splice loss and distance correctly, it is necessary to set the ✳ or × marker at the beginning of the step on the trace waveform as shown below.

Good



(a) Falling step (b) Rising step (c) Falling step with Fresnel reflection

Bad



(a) Falling step (b) Rising step (c) Falling step with Fresnel reflection

(2) Averaging

Read the measured values after obtaining a sufficiently smooth waveform trace using averaging. If you are not sure for how long or how many times to perform averaging, set a large value and press the F5 (Stop) key when a smooth waveform is displayed on the screen during averaging.

(3) Selecting LSA or 2PA linear approximation

Basically, use LSA to find splice losses, and 2PA for total loss.

4.2.2 Calling Event Table

F5

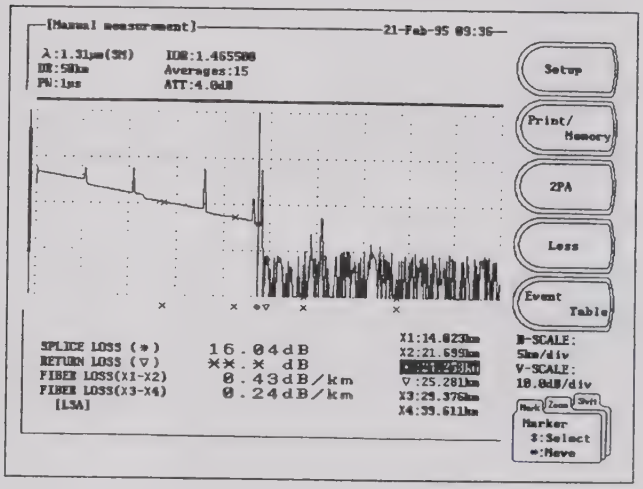
When the F5 (Event Table) key is pressed, the Event Table screen is displayed using the data collected in the Manual mode. The event markers can be displayed at the faults in the same way as at Auto measurement.

For details, see section 4.1 (2).

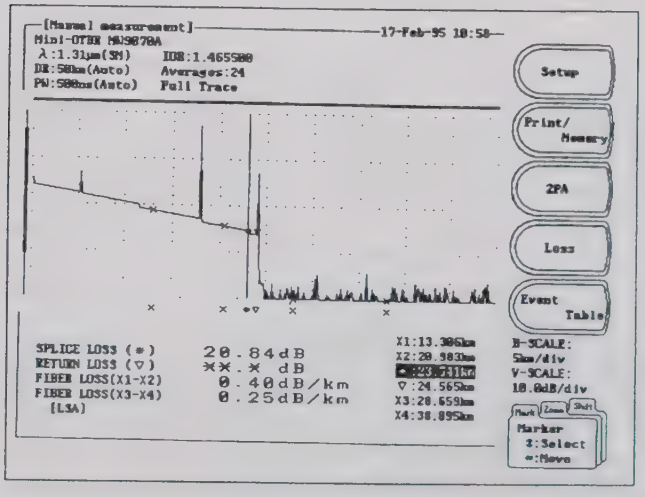
4.3 Full Trace

When an optical unit with an attenuator is used and the attenuator is set to Auto at the Setup screen, the attenuator is automatically switched to the best value to sweep the optical cable. Each trace obtained under the best attenuation is concatenated to display a single screen display. However, this function is not supported in real-time measurement. When the concatenation is performed, Full Trace is displayed at the top part of the screen instead of the attenuation.

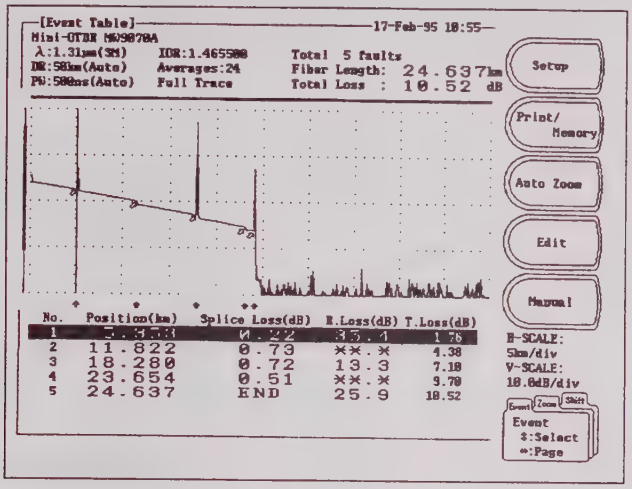
When any value is set at Attenuator of the Setup screen and measurement is performed, the used attenuation is displayed as shown below:



When Attenuation is set to Auto at the Setup screen, Full Trace is displayed instead of the attenuation value as shown in the two figures below:



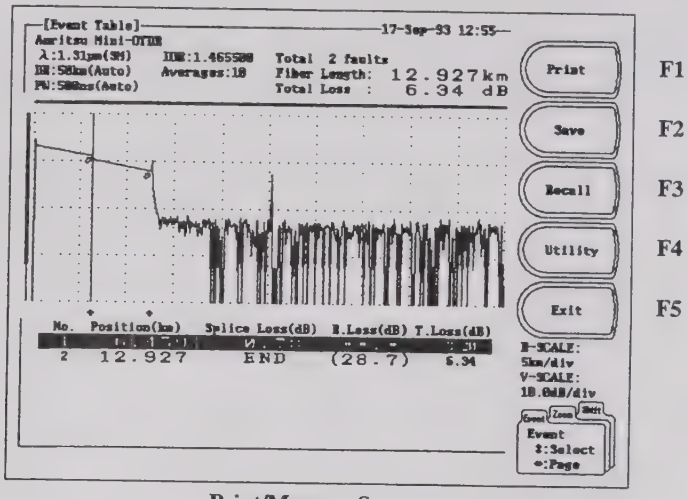
(At manual measurement)



(At event measurement)

4.4 Printing, Saving, Recalling

The following screen is displayed when the F2 (Print/Memory) key is pressed.



Print/Memory Screen

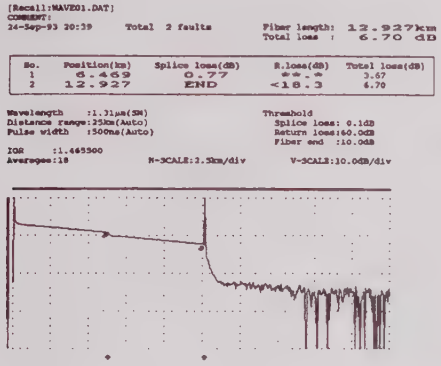
Note: If the F2 (Print/Memory) key is pressed while opening the Setup screen, Save DFN is displayed in the F2 key label.

See section 3.3.

4.4.1 Printing

Either the measurement results and waveform data, or just the measurement results can be printed. Specify this print item and the printer type at the Print field on Setup screen 2. See section 2.9 for the printer connection.

The following sample shows a printed result when the "measurement resuls and waveform" is specified.

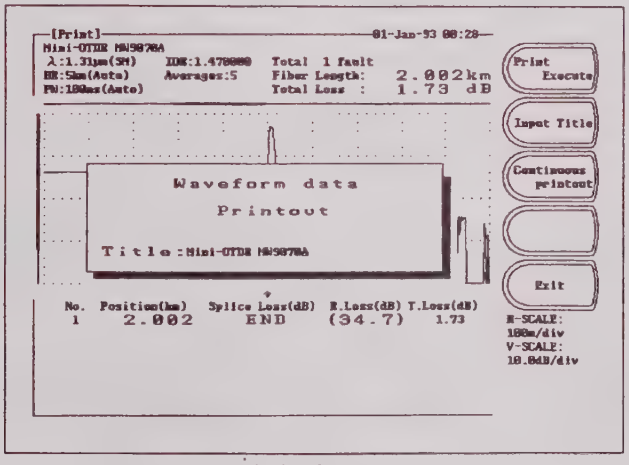


Note: When an error occurred in printing, turn off the power, clear the causes of error, and then turn on the power again.

Print/ Memory F2

The following screen is displayed when the F1 (Print) key at the Print/Memory screen is pressed.

Print F1



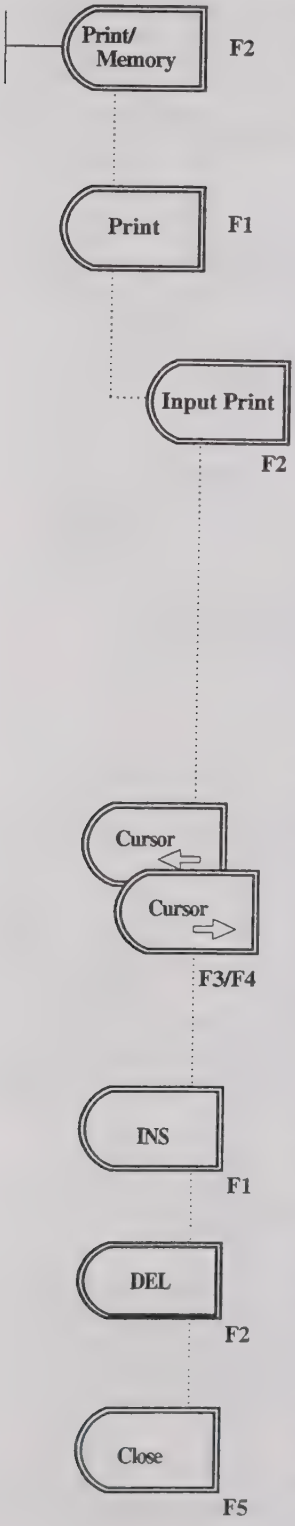
Print Screen

The title to be set at the top left of the screen is displayed as a sub-window. This is the title that was set at Setup screen 1. To change this title for print, input the changes as described below and press the F1 (Print Execute) key. If the displayed title does not need changing, just press the F1 (Print Execute) key.

Exit F5

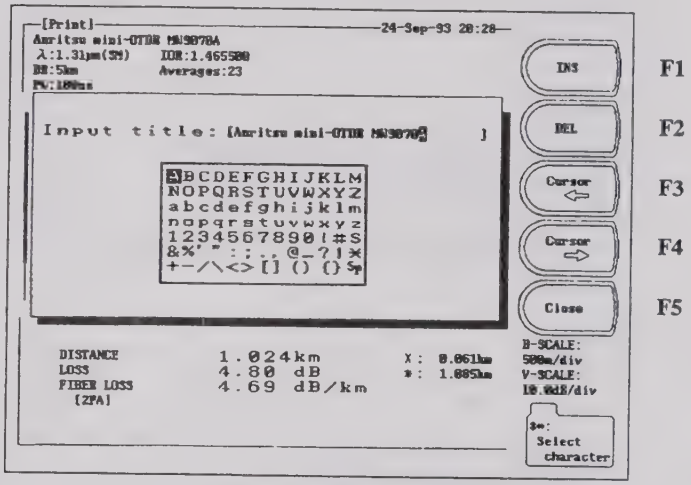
Exit

When the F5 (Exit) key is pressed, the Print screen is closed and the Print/ Memory screen is returned.



Inputting or Changing Title

When the F2 (Input Title) key is pressed, the area at the right side of the Title: display becomes reverse displayed. This reverse-displayed area is called the cursor; characters and spaces can be inserted or deleted at the cursor area. A maximum of 32 characters can be input.



Input Title Screen

Inputting Characters

The characters that can be input are displayed in a rectangular box. One of the characters in the box is reverse displayed. The reverse-displayed character can be moved up, down, left and right using the ∧, ∨, < and > keys.

When the cursor is positioned at the character to be input, press the F4 (Cursor ⇨) key; the character is input and the cursor moves one character to the right. If the F3 (Cursor ⇦) key is pressed, the character is input in the same way, but the cursor moves one character to the left.

Inputting Spaces

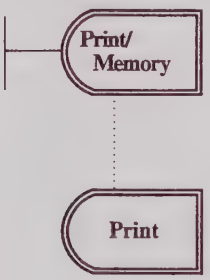
When the F1 (INS) key is pressed, one space is inserted in front of the character where the cursor is positioned.

Deleting Character

When the F2 (DEL) key is pressed, the character where the cursor is positioned is deleted.

Confirming Title

When the F5 (Close) key is pressed, the input title is confirmed and the Input Title screen is closed.



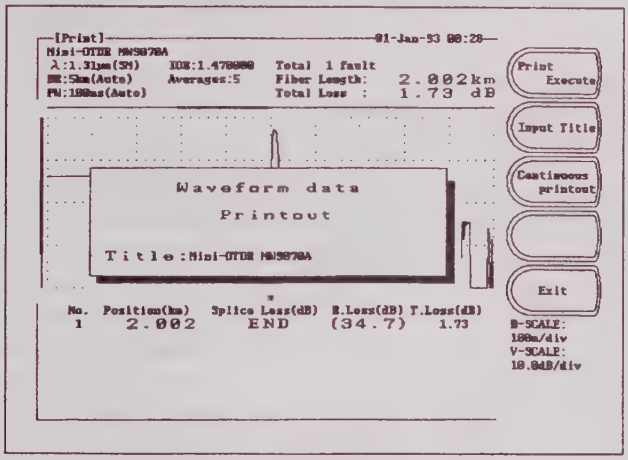
Continuous Printout

Measurement data saved to internal memory, memory card, and FD can be printed continuously and repeatedly in the specified sequence.

The print format is the format specified by the Print format item at the Setup Screen 2.

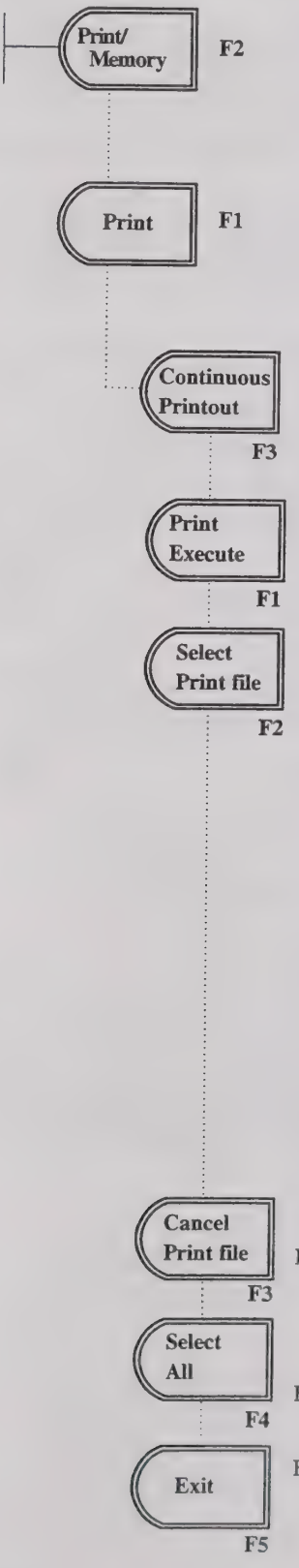
At continuous printing, the file is read and printed continuously and automatically. Consequently, the currently-displayed waveform is lost, so execute Save if it must be saved.

The following screen is displayed when the F1 (Print) key at the Print/Memory screen is pressed.



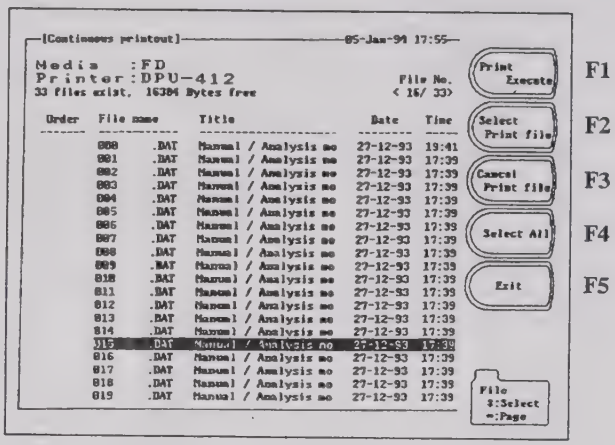
Print Screen

First you press F3 (Continuous Printout) key to display a file list and move the cursor with the ∧ or ∨ keys. Press F2 (Select) key if you want to print the selected file; otherwise use the arrow key to move cursor to another file. A number is displayed at the left end on the line you selected and printing is performed in this order. Use F3 (Cancel) key to cancel your selection. After completing the select procedure, press F1 (Execute) key to proceed the Print Execute Screen.



F3: Continuous Printout

Displays file list as follows:

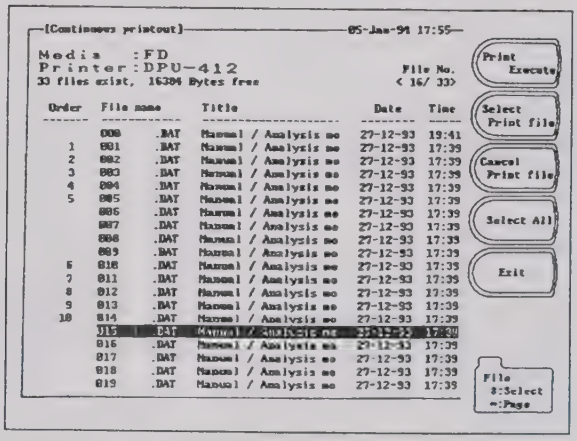


F1: Print Execute

Executes continuous printout

F2: Select Print file

Selects currently reverse-displayed file to be printed. The reverse-displayed file name is prefixed with a number in the order specified by the Select key and the reverse display moves to the next file name. Printing is performed in this order. Move the position of the reverse display to the name of the file to be printed by pressing the ∧ and ∨ keys.



F3: Cancel

Cancels printing of currently reverse-displayed file. The number prefixed to the file name is deleted and the reverse display moves to the next file name. Numbers after the canceled number are decremented by 1.

F4: Select ALL/Cancel ALL

Toggles selecting all files to be printed or deleting all order numbers

F5: Exit

Returns to Waveform screen

4.4.2 Saving

The F2 key with the label "Print/Memory" can save the waveform screen as a file.

☞ See section 3.3 for details of saving screen when the Setup screen is displayed.

Applicable media

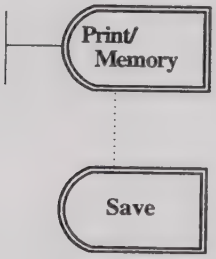
The screen can be saved either in internal memory, memory card a floppy disk. The media to be used is specified in the Target of Memory field of Setup screen 2.

Note: A memory card and floppy disk must be formatted before it can be used.

☞ For details, see section 4.5 (2).

Save format

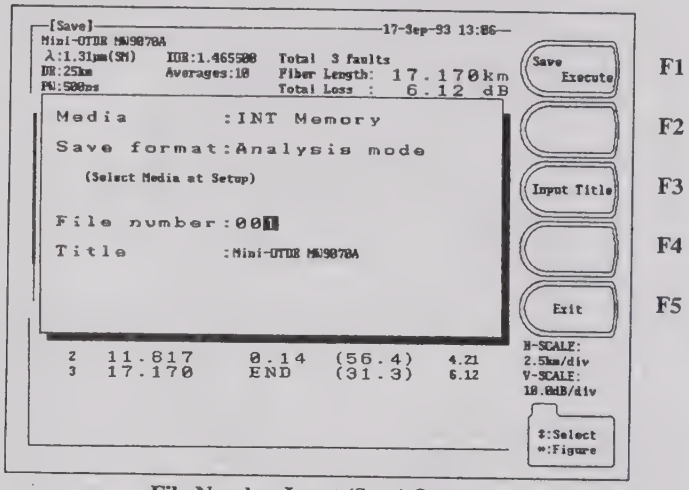
Two types of save format can be selected for printing or analysis. In the Print mode format, the data is saved in a format that can only be printed. In the Analysis mode format, saved data can be printed, markers can be set and manual measurement can be performed. Consequently, the data volume becomes larger. These two formats are specified in the save format of Memory field of Setup screen 2.



The following screen is displayed when the F2 (Save) key at the Print/Memory screen is pressed.

(1) When the "File ID" is set to "Number"

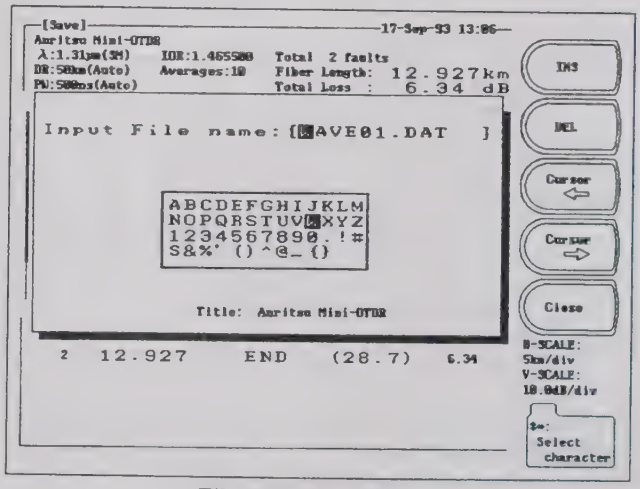
The following screen is displayed when the "File ID" is set to "Number" at the Setup screen 2. Use the ∧ or ∨ keys to increment or decrement, respectively. Refer to the save screen explanation (page 76) for the function keys.



File Number Input (Save) Screen

(2) When the "File ID" is set to "Name"

The following screen is displayed when the "File ID" is set to "Name" at the Setup screen 2.



File Name Input Screen

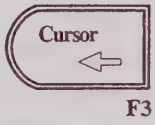
Inputting file name

It is necessary to input a file name when saving a waveform.

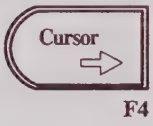
The file name can be 8 digits long with a 3-digit extension after a period. If only a name is input, the OTDR automatically appends the extension .DAT to the name. But, DAT is not appended when the F5 (Close) key is pressed to complete title inputing after inputting a period.

The reverse-displayed file-name input field is called the cursor, and characters and spaces can be input and deleted at this position.

All the characters that can input are displayed in a rectangular box displayed at the bottom left of the screen. The reverse-displayed character in this box can be moved up, down, left and right using the ∧, ∨, 〈 and 〉 keys.

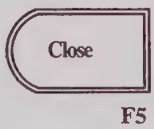


When the character to be input in the title is reverse displayed, press the F4 (Cursor ⇨) key; The character is input to the title and the cursor moves to the next right position. If the F3 (Cursor ⇦) is pressed, the character is input in the same way and the cursor moves to the next left position.



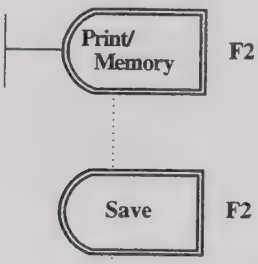
When the F1 (INS) key is pressed, one space is inserted in front of the character where the cursor is positioned.

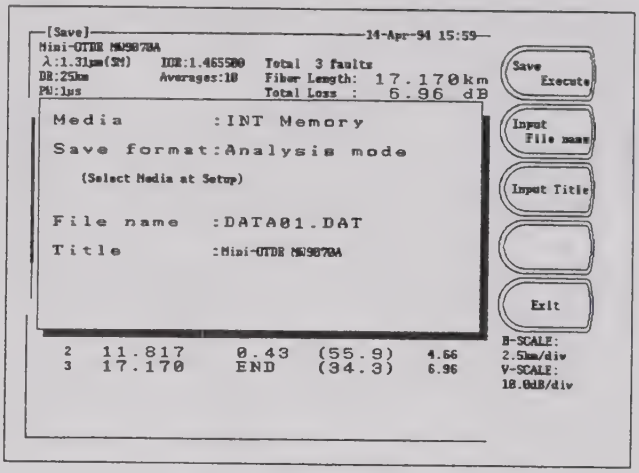
When the F2 (DEL) key is pressed, the character where the cursor is positioned is deleted.



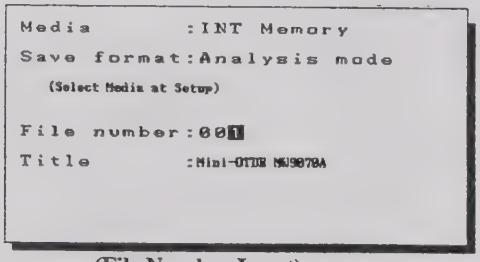
When the F5 (Close) key is pressed, the title input is completed and the screen shown on the following page is returned.

Note: If an attempt is made to input a file name with the same name as an existing file, a file overwriting confirmation message is displayed.





Save Screen (File Name Input)



(File Number Input)

Inputting required title

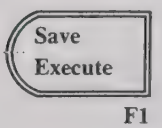
To change the title displayed at the top left of the screen, press the F3 (Input title) key. A title of up to 32 characters can be input. The input method is the same as the title input method for printing described in section 4.4.1.

Re-inputting required file name

When the F2 (Input File Name) key is pressed, the file name can be updated to a new name.

Exiting saving

Press the F5 (Exit) key to stop saving and return to the waveform screen.



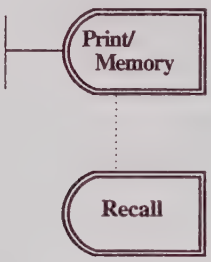
Executing saving

When F1 (Execute Save) is pressed, the file is saved at the media specified by the Target of the Memory field in Setup screen 2 in the format specified at the Save format of the Memory field.

Note: See Appendix A for the number of files stored in each medium.

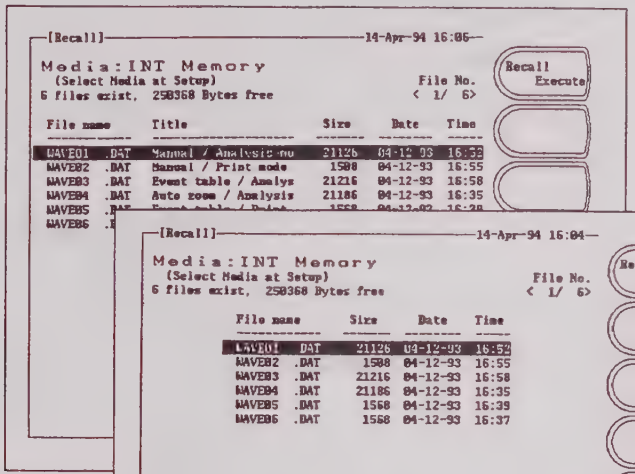
4.4.3 Recalling

Saved files can be recalled and printed at any time.

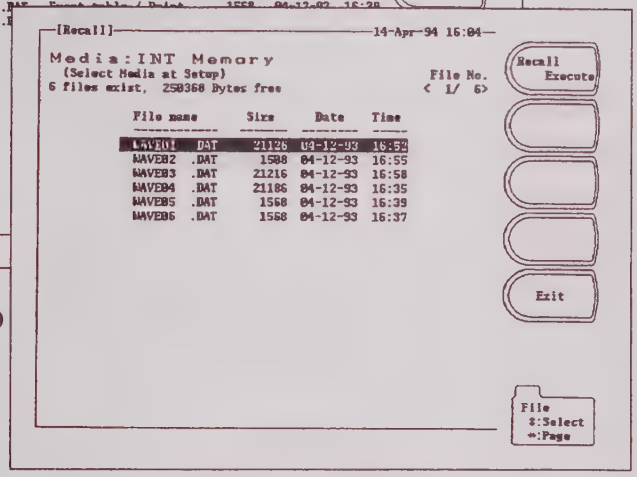


See section 3.4 for recalling a file while the Setup screen is displayed.

When the F3 (Recall) key at the Print/Memory screen is pressed, the following screen is displayed.



Recall Screen (with title)



Recall Screen (None title)

Selecting file name

Move the cursor with the <, >, ∧ and ∨ keys to select the name of the file to be recalled.

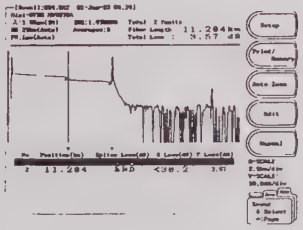
Analyzing waveform

As shown in the above diagram, saved files are either about 1.5 KB or 21 KB in size. 21 KB files can be recalled for manual measurement.

See section 4.2.

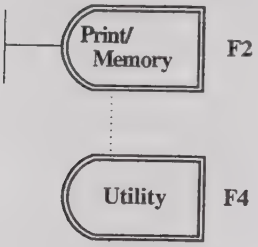
In addition, faults on the waveform trace can be automatically searched for.

See section 4.2.2 for details.

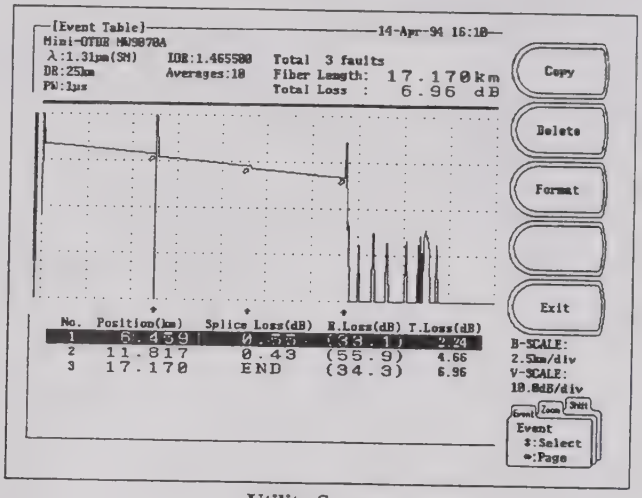


Recalled Waveform

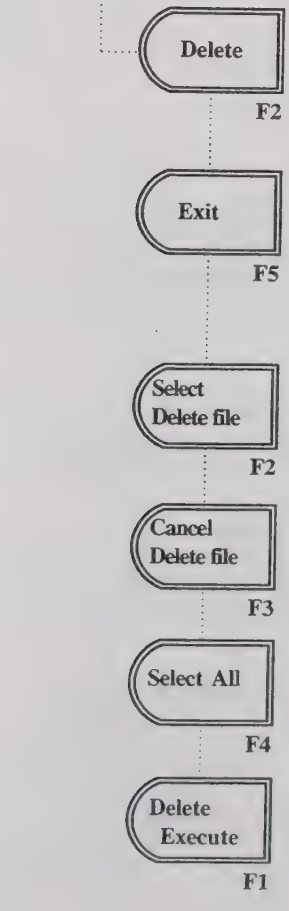
4.5 File Operations



When the F4 (Utility) key at the Print/Memory screen is pressed, the following screen is displayed.

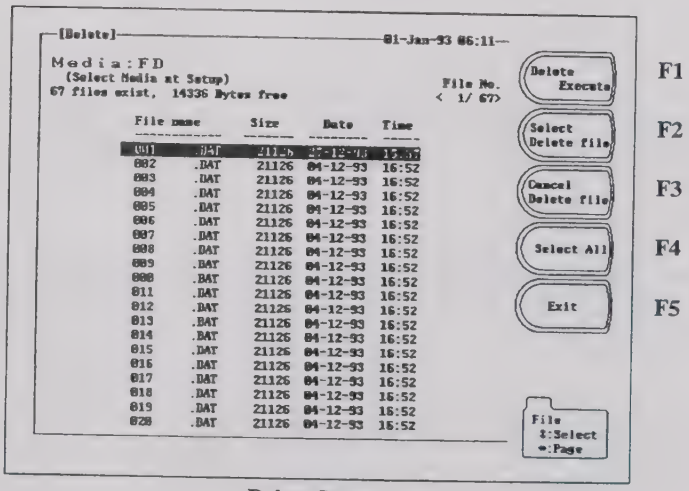


Utility Screen



(1) Deleting files

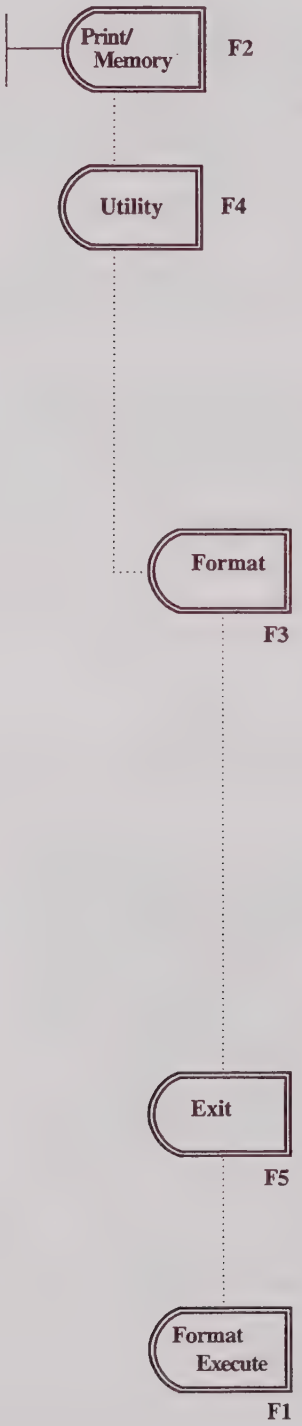
When the F2 (Delete) key at the Utility screen is pressed, files saved at the media specified in the Target of Memory field of Setup screen 2 are listed. Press the F5 (Exit) key to complete the listing.



Delete Screen

Use the ∧, ∨, 〈 and 〉 keys to move the cursor to the file to be deleted and press the F2 (Select Delete File) key. An asterisk (＊) is displayed at the head of the file name. To remove this marker and cancel the deletion, press the F3 (Cancel Delete File) key. Use F4 (Select All/Cancel All) for selecting all files or cancelling to select all files.

To delete files prefixed by ＊, press the F1 (Delete Execute) key.



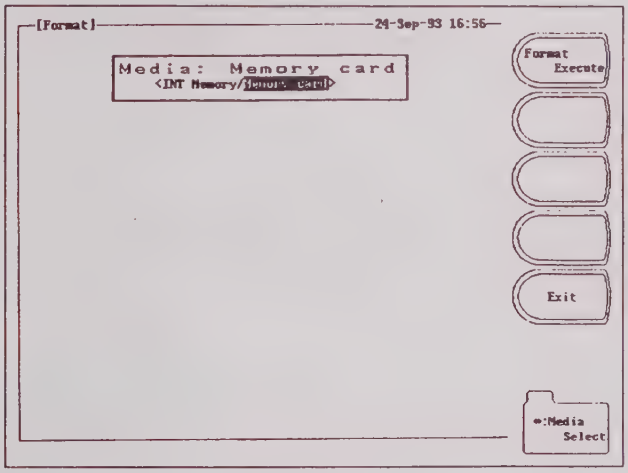
(2) Format

When the F3 (Format) key at the Utility screen is pressed, the media specified at the Target of Memory field of Setup screen 2 is formatted for MS-DOS and the media can be used to store data. (The internal memory can be used without formatting.)

CAUTION

Formatting erases all the files on the medium and erased files cannot be recovered. Make sure that you do not erase an important file by mistake.

Note: Formatting can be used to erase all saved files. This does affect the DFN file.



Format Screen

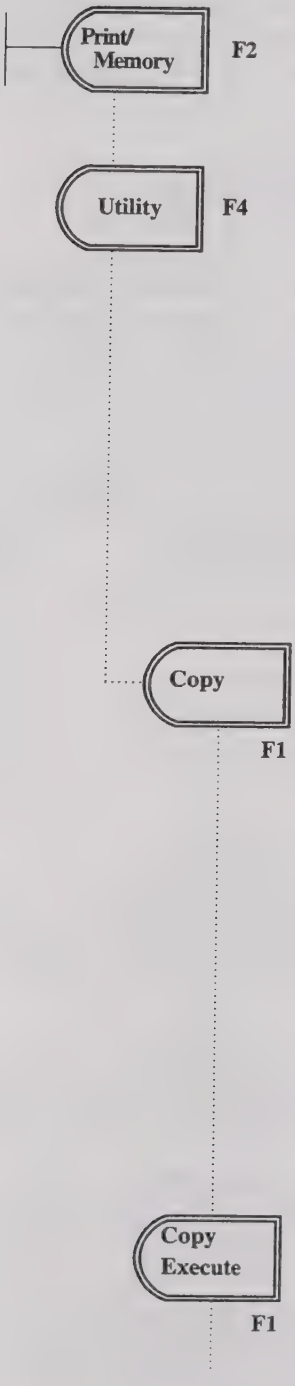
To stop formatting, press the F5 (Exit) key. The waveform screen is returned.

The sub-window displayed in the screen can be used to change the media to be formatted with the cursor keys.

Format OK? is displayed when the F1 (Format Execute) key is pressed.

Formatting is started when the F1 (Yes) key is pressed. The waveform screen is returned when the formatting is completed.

The Format screen is returned when the F2 (No) key is pressed.



(3) Copying Data

Measurement data saved to internal memory, memory card, or FD can be copied as the same file name to other media described above.

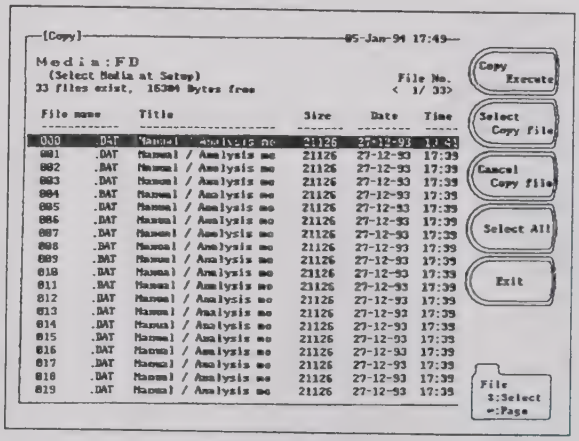
The copy origin media is the item specified by Memory target in the Setup Screen 2. The Copy destination media can be specified in the Copy Execute Screen.

The copy operation has no effect on the currently-displayed waveform screen.

The F1 (Copy) key has been added to the Utility Screen shown in item 4.4 "File Operations" of the Operation Manual. Two screens have been added under the F1 (Copy) key as shown below.

First you press F1 (Copy) key on the Utility Screen to display a file list and move the cursor (reverse-displayed line) with the ∧ or ∨ keys. Press F2 (Select Copy File) key if you want to copy the selected file; otherwise use the arrow key to move cursor to another file. Or repeat this operation if you want to copy multiple files. An asterisk (*) is displayed at the left end on the line you selected. Use F3 (Cancel Copy File) key to cancel your selection. After completing the select procedure, press F1 (Copy Execute) key to proceed the Copy Execute Screen. The Copy destination media can be specified in the screen. And then, press F1 (Copy Execute) key to proceed the copy.

F1: Copy
Displays file list as shown below

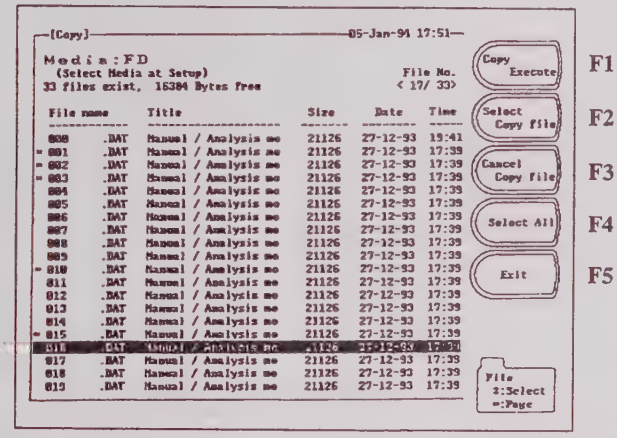

[Copy]
05-Jan-94 17:49
Media : FD
(Select Media at Setup)
33 files exist, 16384 Bytes free
File No.
< 1/ 33>
File name
Title
Size
Date
Time
000 .DAT Manual / Analysis no 21126 27-12-93 17:39
001 .DAT Manual / Analysis no 21126 27-12-93 17:39
002 .DAT Manual / Analysis no 21126 27-12-93 17:39
003 .DAT Manual / Analysis no 21126 27-12-93 17:39
004 .DAT Manual / Analysis no 21126 27-12-93 17:39
005 .DAT Manual / Analysis no 21126 27-12-93 17:39
006 .DAT Manual / Analysis no 21126 27-12-93 17:39
007 .DAT Manual / Analysis no 21126 27-12-93 17:39
008 .DAT Manual / Analysis no 21126 27-12-93 17:39
009 .DAT Manual / Analysis no 21126 27-12-93 17:39
010 .DAT Manual / Analysis no 21126 27-12-93 17:39
011 .DAT Manual / Analysis no 21126 27-12-93 17:39
012 .DAT Manual / Analysis no 21126 27-12-93 17:39
013 .DAT Manual / Analysis no 21126 27-12-93 17:39
014 .DAT Manual / Analysis no 21126 27-12-93 17:39
015 .DAT Manual / Analysis no 21126 27-12-93 17:39
016 .DAT Manual / Analysis no 21126 27-12-93 17:39
017 .DAT Manual / Analysis no 21126 27-12-93 17:39
018 .DAT Manual / Analysis no 21126 27-12-93 17:39
019 .DAT Manual / Analysis no 21126 27-12-93 17:39
Copy Execute
F1
Select Copy File
F2
Cancel Copy file
F3
Select All
F4
Exit
F5
File
S:Select
e:Page

File Copy Screen

F1: Copy Execute
Fetches Copy Destination Selection Screen (See 74 page.)

F2: Select Copy File

Selects reverse-displayed file name as file to be copied. The reverse-displayed file name is prefixed with an asterisk (*), and the reverse display moves to the next file name. Move the position of the reverse display to the name of the file to be copied by pressing the ∧ or ∨ keys.



File Selection Screen

F3: Cancel Copy File

Cancels copying of reverse-displayed file name. The asterisk prefix is deleted and the reverse display moves to the next file name. Move the position of the reverse display to the name of the file to cancel copying by pressing the ∧ and ∨ keys.

F4: Select ALL/Cancel ALL

Toggles selecting all files to be copied or deleting all asterisks

F5: Exit

Returns screen to Waveform screen or Setup Screen

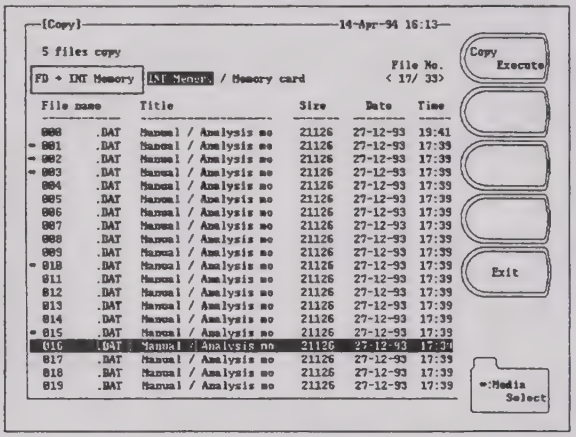
Copy
F1

Copy
Execute
F1

Copy Destination Selection Screen

This screen is used to select the copy destination media. Select the media in the same way as described for the Setup Screen.

The copy origin can only be changed at the Setup Screen 2.



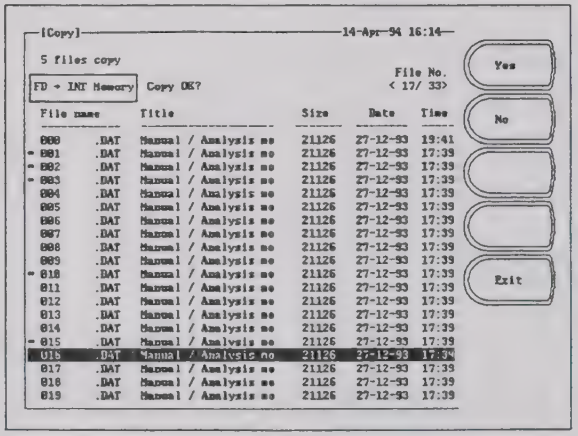
Copy Destination Selection Screen

Yes
F1

F1: Copy Execute

When F1(Copy Execute) key is pressed, the following copy confirmation screen is displayed.

To execute the copying, first check the destination media for proper media mounting and for write enable setting, and then press F1 (Yes) key. After executing the copy, the original waveform screen or setup screen is returned.



Copy Confirmation Screen

No
F2

To quite the copying, press F2 (No) key, and the file selection screen is returned.

Exit
F5

F5: Exit

Copying is not executed and the original Waveform screen or Setup Screen is returned.

4.6 Measurement Examples

The following six measurement examples are described here.

(1) Absolute distance measurement
(2) Relative distance measurement
(3) Connection loss measurement (splice)
(4) Connection loss measurement (connector)
(5) Transmission loss measurement
(6) Return loss measurement

To perform these measurements, the OTDR must first be set as follows:

1 Set the Power switch to ON and check that the Setup screen is correct.

2 Set the measurement mode to Loss. (The F4-key label displays Splice & Loss.)

3 If the wavelength (λ) of the optical unit can be selected, set the correct value.

4 Press the F1 (Setup) key to display the Setup screen, and set the Distance range to 10 km.

5 Set the Pulse width to 100 ns.

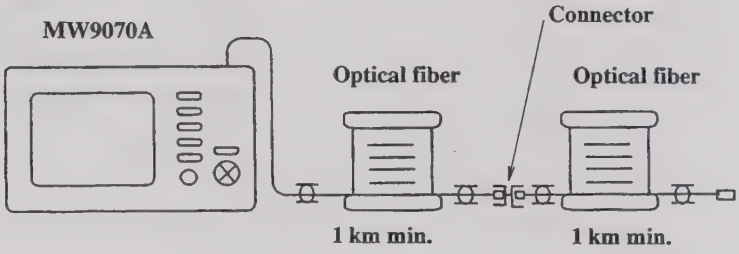
6 Set the index of refraction (IOR) of the fiber.

(1) Measuring absolute distance

The distance from the OTDR to the marker is measured.

Setup

Connect the OTDR as shown below.



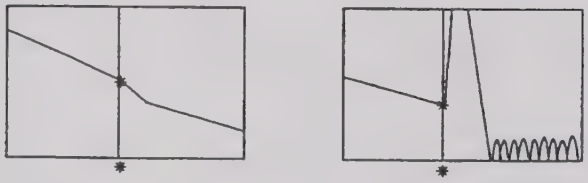
The cable length in this setup is 10 km max.

Measurement Procedure

1 Press the [Start] key.

2 Set the ✳ marker to the connector point or to the end of the fiber[Note].

Connector point **Fresnel reflection point**



3 Zoom both the horizontal and vertical scales to the maximum.

4 Press the F2 (Average ON) key if there is a lot of noise in the waveform.

5 Position the cursor exactly at the fault.

6 The value at DISTANCE on the lower part of the screen is the distance from the OTDR to the marker.

Note: When measuring the distance to the marker, set the marker to the beginning of the step where the waveform changes that is near to the OTDR.

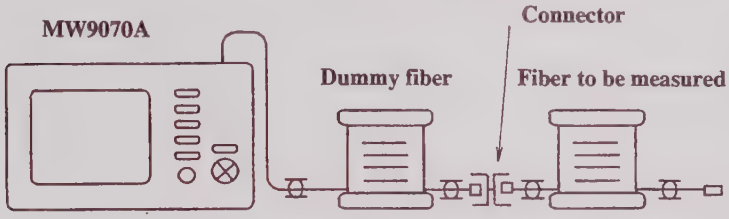
☞ See section 4.2.1(1) for details.

(2) Measuring relative distance

The distance between markers is measured.

Setup

Connect a dummy fiber in front of the fiber to be measured as shown below.



The cable length in this setup is 10 km max.

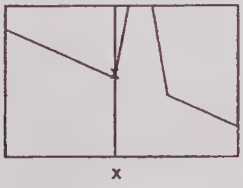
Measurement Procedure

1 Press the [Start] key.

2 Press the [Select] key so that the card with Mark on the tag, which is displayed at the bottom right of the screen, is at the front of the card pile. The cursor can be moved with the > and < keys.

3 Select the × marker with the ∧ and ∨ keys.

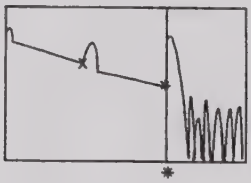
4 Use the > and < keys to match the position of the × marker to the rising edge of the Fresnel reflection observed at the connection between the dummy fiber and the fiber to be measured. Press the [Select] key so that the Zoom card is at the front of the card pile, and use the cursor keys to expand the screen. Press the [Select] key once again so that the Mark card is at the front of the pile and match the marker exactly to the rising edge of the trace. Note the position of the × marker displayed at the bottom right of the screen.



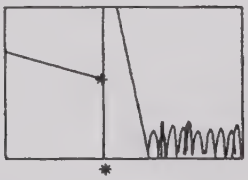
5 Press the [Select] key so that the Zoom card is at the front of the card pile, and compress the screen with the cursor keys so that the Fresnel reflection at the cable end is displayed.

6 Press the [Select] key so that the Mark card is at the front of the card pile, and select the ✳ marker with the ∧ and ∨ keys.

7 Use the > and < keys to match the position of the ✳ marker to the rising edge of the Fresnel reflection observed at the end of the cable.



8 Press the [Select] key so that the Zoom card is at the front of the card pile, and use the cursor keys to expand the screen. Press the [Select] key once again so that the Mark card is at the front of the pile, and match the marker exactly to the rising edge of the trace.

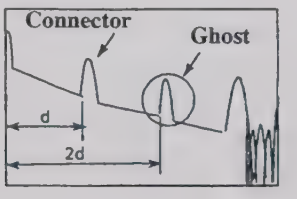


9 If there is a lot of noise in the trace, press the F2 (Average ON) key to perform averaging.

10 When the ✳ marker is positioned exactly at the rising edge, note the position of the ✳ marker displayed at the bottom right of the screen.

11 The distance between the × and ✳ markers is found by subtracting the position of the × marker from the position of the ✳ marker.

Note: Be careful about ghosts occurring at measurement. Ghosts occur when the reflected light from a connector is reflected again at the OTDR. These ghosts appear at integer multiple distances of the connector, and can be identified quite easily from this characteristic. To prevent ghosting, adjust connectors properly and use matching oil, etc. on the end faces of connectors to minimize the reflection.

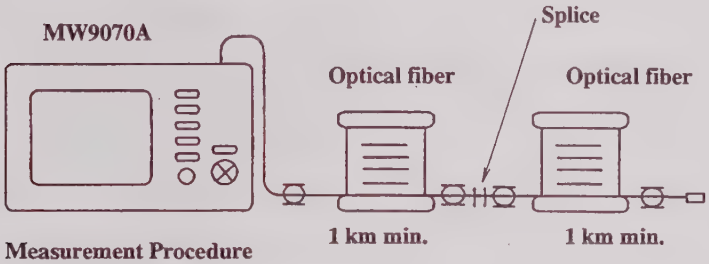


(3) Measuring connection loss (splice)

The connection loss of a splice in the fiber is measured.

Setup

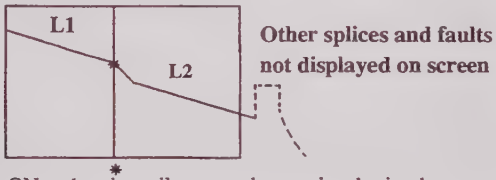
Connect the OTDR as shown below.



Measurement Procedure

1 Press the [Start] key and set the ✳ marker to the beginning of the splice step near to the OTDR.

2 Position the splice at the center of the screen so that only the straight sections ((L1) and (L2) in the figure below) of the fiber before and after the splice are displayed on the screen. In other words, other splices and faults should not be displayed on the screen.



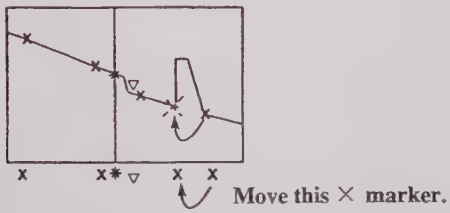
3 Set Averaging to ON and wait until a smooth trace is obtained.

4 Press the F4 (Splice & Return Loss) key to set the Splice & Return Loss mode.

5 Press the F3 (LSA) key to set the linear approximation method to LSA.

6 The splice loss is displayed at SPLICE LOSS field at the bottom left of the screen.

Note: When a splice other than the target splice, or Fresnel reflection is displayed on the screen between two × markers, move the outermost of the two × markers to the inside point as shown below so that the other splice or Fresnel reflection is not included between the two × markers. In this case, the two × markers should be as far apart as possible.

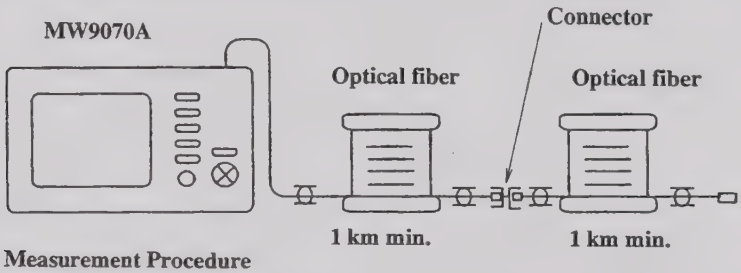


(4) Measuring connection loss (connector)

The connection loss of a connector in the fiber is measured.

Setup

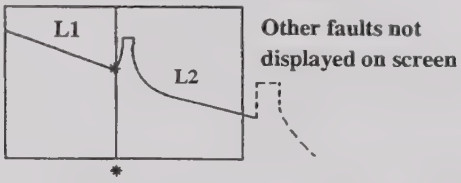
Connect the OTDR as shown below.



Measurement Procedure

1 Press the [Start] key and set the ✳ marker to the rising edge of the Fresnel reflection.

2 Position the connector at the center of the screen so that only the straight sections ((L1) and (L2) in the figure below) of the fiber before and after the connector are displayed on the screen. In other words, other connectors and faults should not be displayed on the screen.



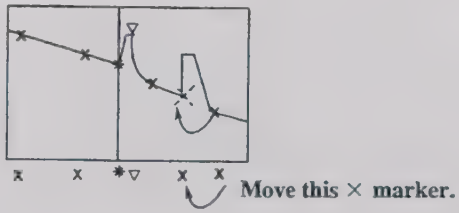
3 Set Averaging to ON and wait until a smooth trace is obtained.

4 Press the F4 (Splice & Return Loss) key to set the Splice & Return Loss mode.

5 Press the F3 (LSA) key to set the linear approximation method to LSA.

6 The connector loss is displayed at SPLICE LOSS field at the bottom left of the screen.

Note: When a connector other than the target connector, or Fresnel reflection is displayed on the screen between two × markers, move the outermost of the two × markers to the inside point as shown below so that the other connector or Fresnel reflection is not included between the two × markers. In this case, the two × markers should be as far apart as possible.

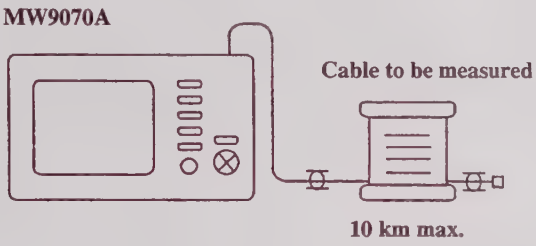


(5) Measuring transmission loss

The fiber transmission loss is measured.

Setup

Connect the OTDR as shown below.



Measurement Procedure

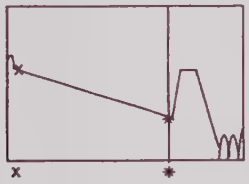
1 Press the [Start] key.

2 Display the Zoom card at the front of the card pile, and use the cursor keys to magnify the screen so that the entire trace waveform is displayed on the screen.

3 Set Averaging to ON and wait until a smooth waveform is obtained.

4 Set 2PA display.

5 Set the × marker to the near end of the fiber and the ✳ marker to the rising edge of the Fresnel reflection at the far end of the cable as shown below.



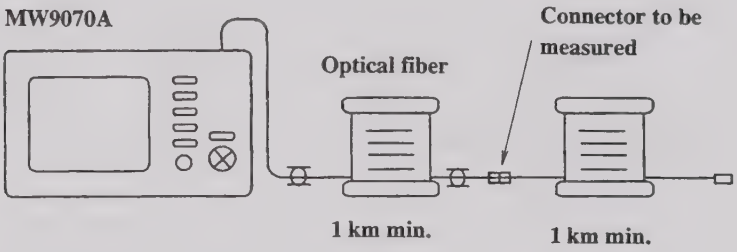
6 Read the Loss value displayed on the screen.

(6) Measuring return loss

The connector is measured.

Setup

Connect the OTDR as shown below.

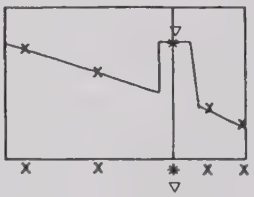


Measurement Procedure

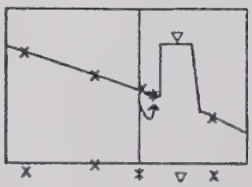
1 Press the [Start] key.

2 Set the Splice & Return Loss mode.

3 Set the ▽ marker to the peak of the Fresnel reflection at the connector to be measured. Display the Zoom card at the front of the card pile, and expand the horizontal and vertical scales with the cursor keys so that the ▽ marker can be positioned accurately.



4 Display the Mark card at the front of the card pile, and select the ✳ marker with the cursor keys. Position the ✳ marker at the rising edge of the Fresnel reflection as shown below.



5 If there is a lot of noise in the trace, set Averaging to ON.

6 Read the Return Loss displayed at the bottom of the screen.

Section 5 Performance Test and Calibration

This section explains how to check the OTDR performance and how to calibrate the measurement results.

If the specifications described in this performance test are not met, call Anritsu Corporation or your nearest service representative.

To help with repair, provide details of the following items.

(1) The model name and the instrument serial number on the back panel

(2) The nature of the fault

(3) The name and contact telephone number of the person in charge for Anritsu to notify the repair time details, etc.

5.1 Performance Test 84
5.1.1 Wavelength 86
5.1.2 Pulse Width 88
5.1.3 Dynamic Range 89
5.1.4 Horizontal Axis Accuracy 90
5.1.5 Vertical Axis Accuracy 91
5.1.6 Optical Output Level 92

5.2 Calibration Setup 93

WARNING

NEVER look directly into the optical output connector of this instrument nor into the end of an optical cable connected to it, because there is a risk of injury if the laser light enters the eyes.

Procedures other than those specified herein may result in hazardous radiation exposure.

5.1 Performance Test

The following six items are tested to check the performance of the OTDR; The optical output level and wavelength of visible LD is only tested when the option 05 Visible LD Light Source is installed.

- Wavelength
- Pulse Width
- Dynamic Range
- Horizontal Axis Accuracy
- Vertical Axis Accuracy
- Optical Output Level and Wavelength of Visible LD Light Source (Option 05)

Clean the optical connector before performing the test. The test procedure described here is performed with an optical unit installed in the main frame and the Power switch set to ON so that the Power lamp is lit. (However, item, 5.1.1 starts with the power off.)

The specifications for performance tests are listed below, and equipment and cables required for them are listed on the following page.

Required Test Specification

Visible LD

Optical Unit	MW0972A						MW0972B							
	MW0970A						MW0970B							
Wave Length	1310±30 nm			1550±30 nm			1310±30 nm			1550±30 nm				
	Pulse Width : 1 μs													
	At 25°C													
Pulse Width (ns)	20	50	100	500	1000	2000	20	50	100	500	1000	2000	4000	10000
Dynamic Range (dB)	*1 6.5/4.0	8.5/6.0	10.0/7.5	13.5/11.0	15.0/12.5	16.5/14.0	10.0/8.0	12.0/10.0	13.5/11.5	21.0/19.0	22.5/20.5	24.0/22.0	28.0/26.0	30.0/28.0
Horizontal Axis Accuracy	±2 m±measured distance×10^{-4}						Horizontal/Vertocal are the same other unit.							
Vertical Axis Accuracy (Linearity)	±0.05 dB/dB or ±0.1 dB													
Optical Output Level	———													

Optical Unit	MW0973J			MW0975J				(Option 05)
Wave Length	850±30 nm			850±30 nm/1300±30nm				635±10 nm
	Pulse Width : 100 ns							
	At 25℃							
Pulse Width (ns)	20	50	100	20	50	100	500	———
Dynamic Range (dB)	11.5	13.5	15.0	*2 11.5/9.5	13.5/11.5	15.0/13.0	—/16.5	———
Horizontal Axis Accuracy	±2 m±measured distance×10^{-4}							———
Vertical Axis Accuracy (Linearity)	±0.05 dB/dB or ±0.1 dB							———
Optical Output Level	———							-3.0±1.5 dBm

*1: Value at 1310 nm / value at 1550 nm

*2: Value at 850 nm / value at 1310 nm

Equipment and Cables Required for Each Performance Test

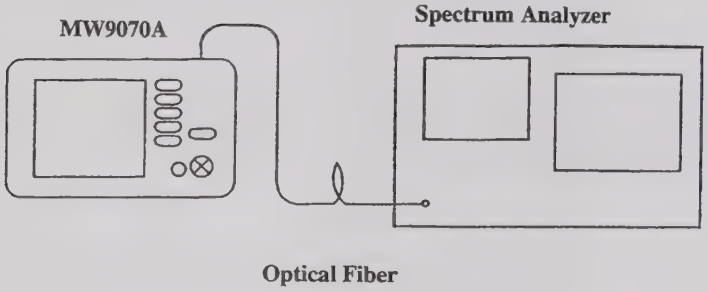
Equipment and Cables \ Test Items	Wavelength		Pulse Width			Dynamic Range		Hor. Axis Accuracy		V. Axis Accuracy		Opt. Out. Level
	OTDR Output	Option 05	SM Unit	GI Unit		SM Unit	GI Unit	SM Unit	GI Unit	SM Unit	GI Unit	Option 05
				0.85 µm	1.3 µm							
Optical Spectrum Analyzer MS9001B Wavelength: 0.8 to 1.6 µm Level: -70 to 0 dBm	○											
MS9030A + MS9702B Wavelength: 0.35 to 1.75 µm Level: -90 to 0 dBm		○										
Optical Variable Attenuator MN924A Wavelength: 1.31/1.55 µm Attenuation: 60 dB min. MN95C (Wavelength: 0.85 µm) MN95D (Wavelength: 1.3 µm) Attenuation: 60 dB min.			○	○	○							
Optical Variable Attenuator MN9002A, Wavelength: 1.31/1.55 µm Attenuation: 60 dB min. MN938A Wavelength: 0.85/1.3 µm Attenuation: 60 dB min.										○	○	
Waveform Monitor MP96A Wavelength: 1.2 to 1.6 µm Rise/Fall Time: 500 ps max. MP95A Wavelength: 0.5 to 1.1 µm Rise/Fall Time: 500 ps max.			○	○	○							
Oscilloscope DC to 200 MHz			○	○	○							
SM Optical Fiber (25 km for MW0970A/72A) SM Optical Fiber (75 km for MW0970B/72B) GI Optical Fiber (2 to 4 km)						○ ○	 ○					
SM Optical Fiber (2 km) GI Optical Fiber (4 km)								○	 ○			
Optical Power Meter ML9001A + MA9001B + MA9411A Wavelength: 0.38 to 1.15 µm Level: -70 to 7 dBm												○

5.1.1 Wavelength

This test checks the center wavelength of the laser optical output.

(1) Setup

Connect as shown in the diagram below.

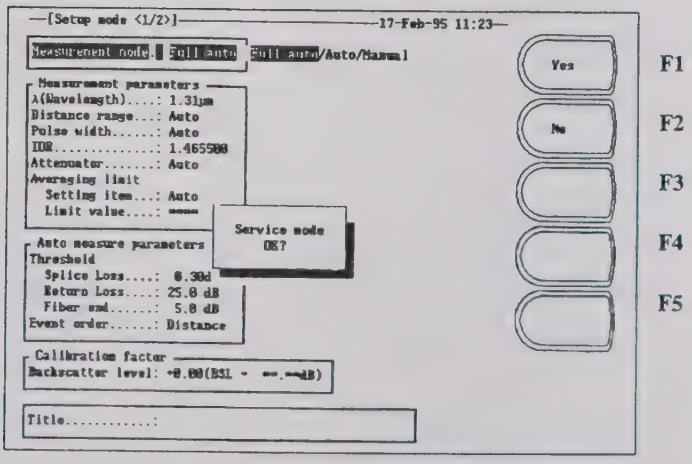


(2) Test Procedure

1 (From power-off status) Turn on the power while pressing the F5 key. Keep pressing the F5 key until the Setup screen is displayed. This sets the service mode.

2 Confirm that the nominal value is displayed in the λ (Wavelength) field of Setup screen 1.

3 Press the [Select] key so that the following screen is displayed.



4 Press the F1 (Yes) key. If you want to stop the performance test at this step, press the F2 (No) key to return to the Setup screen(Note). The following screen is displayed when the F1 (Yes) key is pressed.

5 Set Distance range to 50 km for SM Unit or 5 km for GI Unit at this screen.

6 Set Pulse width to 1 μs for SM Unit or 100 ns for GI Unit .

7 Press the F1 (Execute) key to output the laser continuously. The output can be stopped by pressing the F5 (Stop) key. Press the F1 (Execute) key to restart optical output.

8 Receive the light at the optical spectrum analyzer and adjust the optical spectrum analyzer measurement level and wavelength resolution.

9 Select the RMS method at the optical spectrum analyzer.

10 Confirm that the measurement results are within the specification.

11 When measurement is finished, turn off the power once.

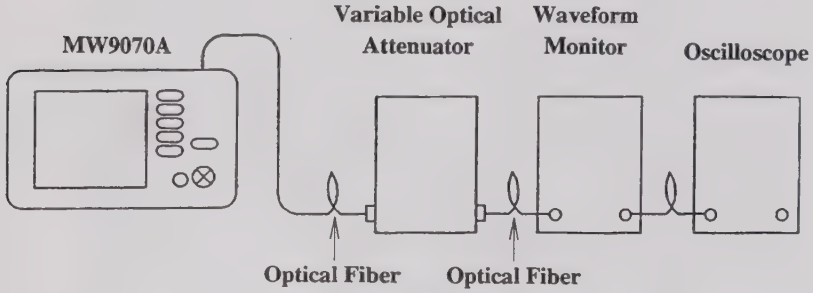
Note: Because the Service mode is held after returning to the Setup screen, pressing the [Select] key displays the screen of the previous page. The Service mode is released by power-off.

5.1.2 Pulse Width

This test checks the pulse width of the laser output.

(1) Setup

Connect as shown in the diagram below.



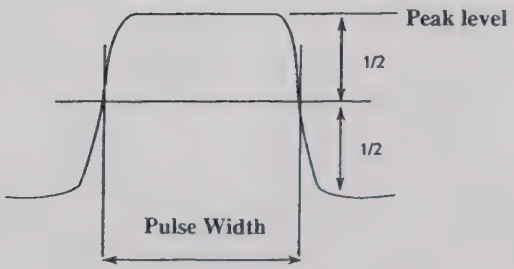
(2) Test Procedure

1 Check the wavelength at the λ (Wavelength) field of Setup screen 1. Select the pulse width to be measured at the Pulse width field.

2 Press the [Start] key.

3 Adjust the oscilloscope amplitude and time axes, and display the waveform on the oscilloscope. Adjust the variable optical attenuator so that the waveform monitor is not saturated at this time.

4 Observe the waveform on the oscilloscope and check that the pulse width is within ±10% for MW0970A/MW0972A/MW0970B/MW0972B and 20% for MW0973J of the nominal value at an amplitude of half the peak level as shown in the diagram below (within ±5 ns at pulse width of 20 ns).

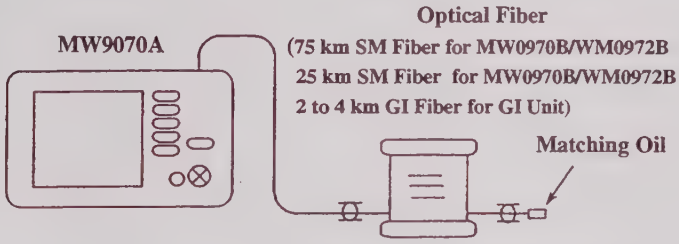


5.1.3 Dynamic Range (one-way backscattered light dynamic range test)

This test checks the dynamic range. Perform this test at each wavelength and pulse width.

(1) Setup

Connect as shown in the diagram below.


MW9070A
Optical Fiber
(75 km SM Fiber for MW0970B/WM0972B
25 km SM Fiber for MW0970B/WM0972B
2 to 4 km GI Fiber for GI Unit)
Matching Oil

(2) Test Procedure

1 Set Manual at the Measurement mode field of Setup screen 1.

2 Check the wavelength at the λ (Wavelength) field.

3 Set 50 km for MW0970A/MW0972A, 100 km for MW0970B/MW0972B or 5 km for GI Unit at the Distance range field.
Set Attenuator to Auto when MW0970B or MW0972B is used.

4 Choose the pulse width for the dynamic range to be measured at the Pulse width field.

5 Set Setting item to Time and Limit value to 180 seconds.

6 Press the [Start] key.

7 Set Averaging to ON and the display mode to Loss.

8 Find the following values from the waveform displayed when averaging is completed.

(a) The level at the OTDR optical connector: A

(b) The noise level at the noise floor level: B

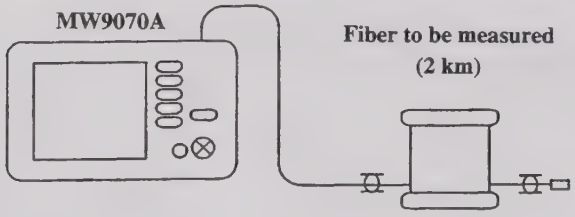
Check that the level difference (A-B) (dynamic range) meets the specifications for each wavelength and pulse width.

5.1.4 Horizontal Axis Accuracy

Measure a fiber length of known length and IOR; this test checks the accuracy of the horizontal scale (distance). It is only necessary to perform this test at one distance range.

(1) Setup

Connect as shown in the diagram below.



(2) Test Procedure

1 Check the wavelength at the λ (Wavelength) field of Setup screen 1.

2 Set Distance range to 5 km.

3 Set Pulse width to 1 µs for SM Unit or 100 ns for GI Unit .

4 Set the IOR for the fiber to be measured at the IOR field.

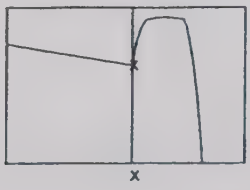
Note: The IOR varies with the wavelength. Check the wavelength at step 1 and then set the correct IOR.

5 Press the [Start] key.

6 Set a marker at the far-end Fresnel reflection and set the horizontal scale to 5 m/div.

7 Set Averaging to ON.

8 Precisely set the marker at the rising edge of the far-end Fresnel reflection and read the absolute distance. Check that this value meets the specifications for the distance measurement accuracy.

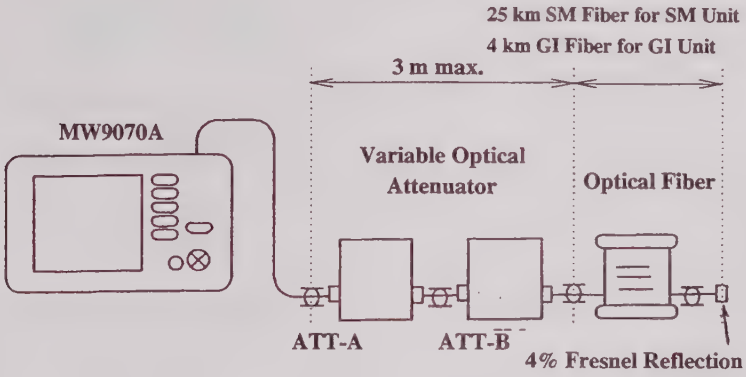


5.1.5 Vertical Axis Accuracy

This test checks the vertical axis accuracy or the accuracy of the measured level. Perform this test at every pulse width and every attenuation.

(1) Setup

Connect as shown in the diagram below. When checking a multimode fiber unit, change the MN9002A Variable Optical Attenuator to the MN938A.



(2) Test Procedure

1 Check the wavelength at the λ (Wavelength) field of Setup screen 1.

2 Set the Pulse width to 100 ns, attenuator to 0 dB when MW0970B or MW0972B is used.

3 Press the [Start] key.

4 Set the Loss display.

5 Set the × marker to the zero level and the ✳ marker to the far-end Fresnel reflection.

6 Set ATT-B to 0 dB and adjust ATT-A so that the far-end Fresnel reflection peak is fractionally lower than the saturation level (within 0.2 dB).

7 Read the level of the Fresnel reflection from the OTDR screen and make this value PL0.

8 Set ATT-B to 2 dB and measure the Fresnel reflection level. Make this value PH0.

9 Return ATT-B to 0 dB and increase the attenuation of ATT-A by 1 dB and measure the Fresnel reflection level. Make this value PL_i.

10 Set ATT-B to 2 dB and measure the Fresnel reflection level. Make this value PH_i.

11 Increase the attenuation of ATT-A in 1 dB steps up to 15 dB to measure PL_i and PH_i at each step.

12 Find the vertical axis accuracy at each ATT-A setting using the following formula and check that they meet the specifications.

$$\text{Vertical axis accuracy} = [(PL_i - PH_i) - \Delta A]/\Delta A$$

ΔA is the previously-calibrated-attenuation difference between ATT-B settings at 0 dB and 2 dB.

5.1.6 Optical Output Level and Wavelength of Visible LD Light Source (Option 05)

WARNING

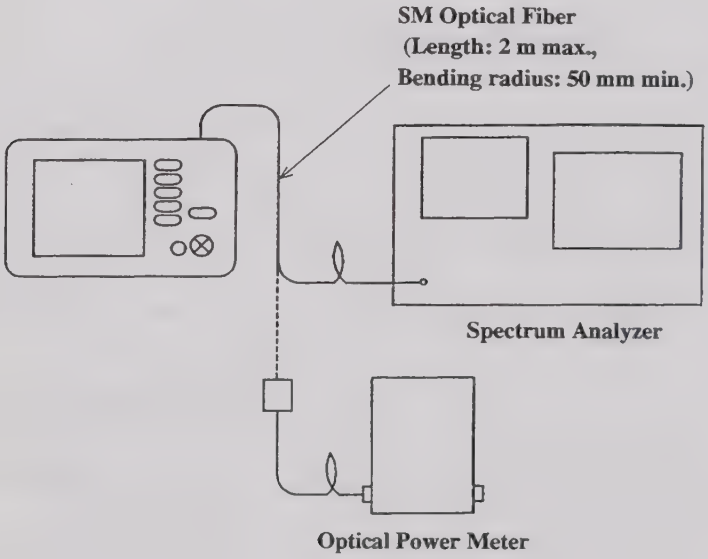
NEVER look directly into the optical output connector of this instrument nor into the end of an optical cable connected to it, because there is a risk of injury if the laser light enters the eyes.

Procedures other than those specified herein may result in hazardous radiation exposure.

This test checks the optical output level and wavelength of the Visible LD Light Source (Option 05).

(1) Setup

Connect as shown in the diagram below.



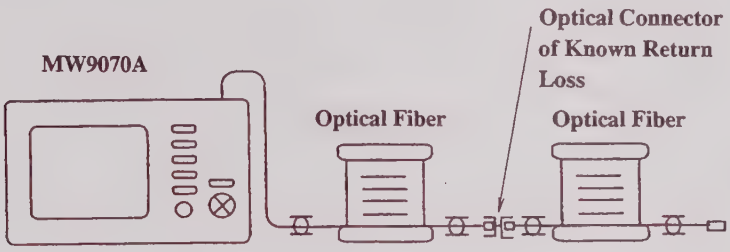
(2) Test Procedure

Turn on the Visible LD Light Source at the Visible LD field of Setup screen 2.

Measure and check that the center wavelength and optical output level meet the specifications using a spectrum analyzer and optical power meter, respectively.

5.2 Calibration Setup

Only the backscattered level can be calibrated.
Prepare an optical connector with a known return loss (R_0 dB) and connect as shown in the diagram below.

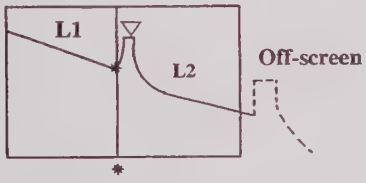


Calibration Procedure

1 Set the Calibration factor displayed at Setup screen 1 to 0.

2 Press the [Start] key. Press the F4 (Splice & Return Loss) key to set the Splice & Return Loss mode. Press the F3 (LSA) key to set the LSA linear approximation method. Set the ✳ and ▽markers at the rising edge and the top of the Fresnel reflection, respectively.

3 Display the connector in the center of the screen, so that only the straight parts before and after the connector are displayed (no other splices or connections or fault points should be displayed on the screen).



4 Set Averaging to ON and wait until the noise disappears.

5 The connection loss is displayed at SPLICE LOSS on the bottom left of the screen. Make this value R_1 dB.

6 Find the difference between the known return loss, R_0 dB, and the measured return loss, R_1 dB, as $R_1 - R_0$. Set this value including the ±sign at Calibration factor of Setup screen 1.

7 Return to the measurement screen and check that the connection loss displayed at SPLICE LOSS is the same as R_0.

Section 6 Maintenance

This section explains how to clean the OTDR to maintain its performance, as well as the steps to take if an abnormality occurs.

6.1 Cleaning Optical Connector 96

6.2 Recharging Battery 97

6.3 Self-Diagnostic Error Display 98

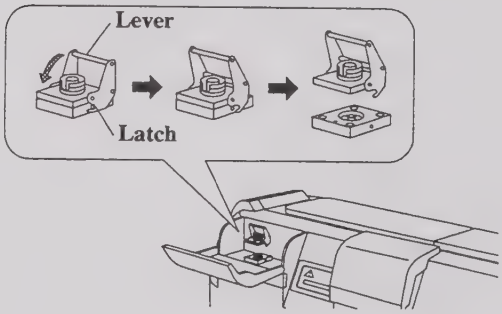
6.1 Cleaning Optical Connector

Clean the optical output connector with the supplied cleaning set (☞ Appendix B) before making a measurement.

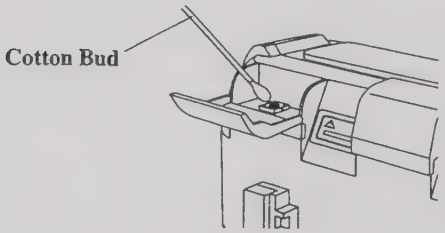
Clean optical connector as described below.

1 Set the Power switch to OFF.

2 Pull the lever forward and check that the latch is released so that the optical connector can be removed.



3 Wet the cotton bud with isopropyl alcohol and clean the face of the equipment-side connector.

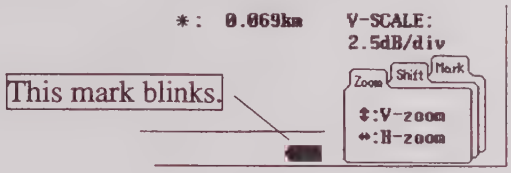


4 Refit the removed optical connector.

Note: When removing and fitting the connector, take care not to scratch the ferrule.

6.2 Recharging Battery

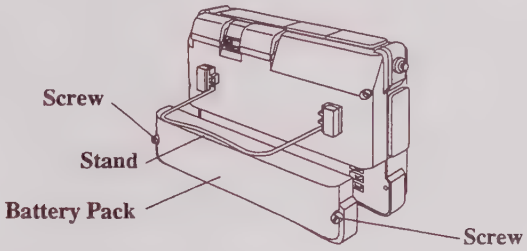
When the battery voltage drops too low, the following alarm display appears on the screen and a buzzer sounds. Complete the current measurement within about 5 minutes and set the Power switch to OFF.



— CAUTION —

The OTDR can be used for about 5 to 15 minutes after the alarm is displayed. This length of time depends on initial charging condition of the batery and operating temperature.

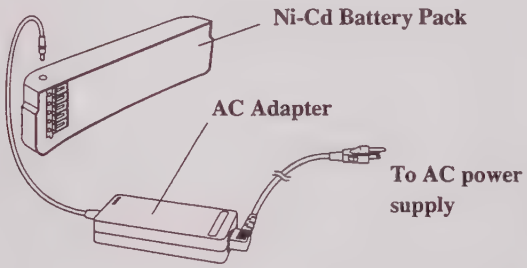
To change the battery to a spare one, raise the stand as shown below, turn the two screws by hand and remove the battery.



— CAUTION —

The MZ5020A Dry-Cell Battery Pack is not rechargeable. NEVER attempt to recharge it.

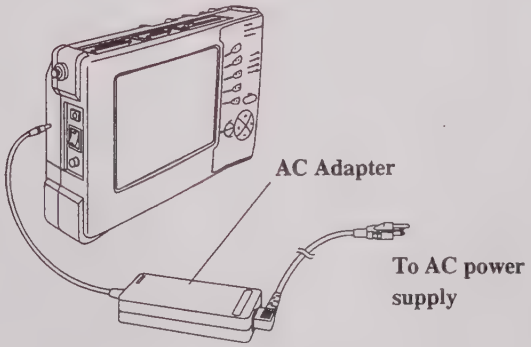
Recharge the removed battery by connecting it to the AC adapter if the Ni-Cd Battery Pack is used.



— CAUTION —

1. **It is necessary to charge the battery for about 14 hours or more to return to full charge. If the battery is charged for more than 20 hours, it may be damaged.**
2. **A partly-discharged battery cannot be fully recharged.**

If the AC adapter is connected to the OTDR with the battery pack installed, the OTDR can be operated while the battery is charging.

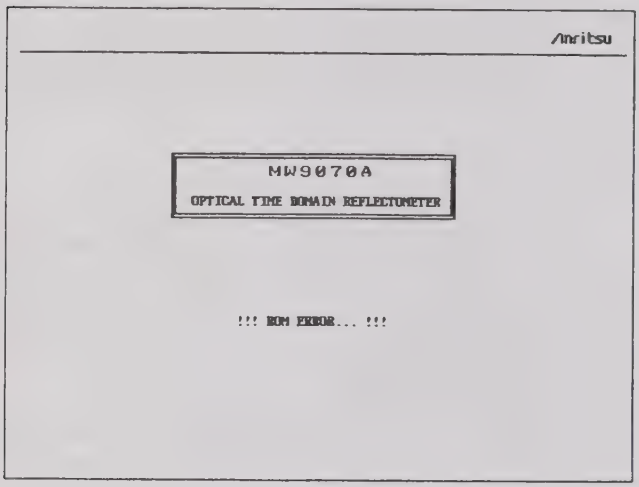


6.3 Self-Diagnostic Error Display

An error message screen is displayed automatically if an abnormality is found in the equipment at power-on.

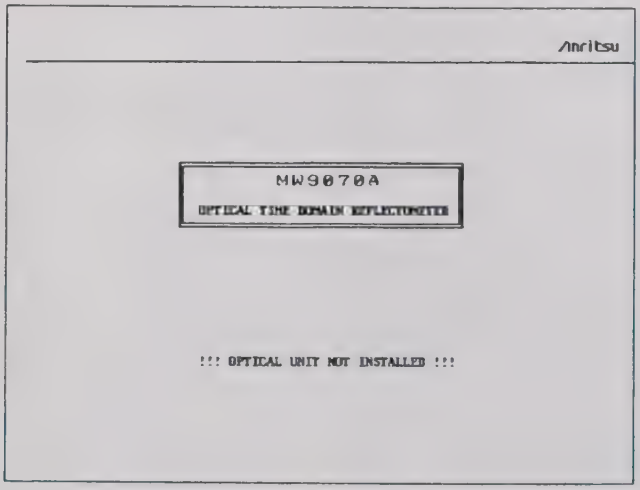
ROM Error

If the following screen is displayed, check the optical unit mounting, and if this does not remedy the problem, call Anritsu Corporation.



Optical Unit Not Installed

If the following screen is displayed, check the optical unit mounting, and if this does not remedy the problem, call Anritsu Corporation.



Appendixes

These appendixes contain the reference information.

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(4) AC Adapter 106
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Appendix C Splice Loss Measurement Principles 110

Appendix D Return Loss Measurement Principles 111

Appendix A Specifications

(1) Main Frame (MW9070A)

Item	Specification	Remarks
Display	640 x 480 dots 110(H) x 147(W) mm 7-inch semi-translucent LCD	Backlighting ON/OFF
Auto measurement function		
Threshold		
Splice loss	0.01 to 9 dB (0.01 dB steps)	
Return loss	20 to 60 dB (1 dB steps)	
Fiber end	1 to 10 dB (1 dB steps)	
Detected events	99 max.	
Automatic setting	Pulse width, Distance range, No. of averagings (automatic only)	
Manual measurement functions	Loss and distance between any two points Loss per unit length between two points Splice loss and Return loss	
Distance units	m/km/ft/kft/mi selectable	
IOR	1.400 000 to 1.699 999 (0.000 001 steps)	Notes
Interface	Serial interface: RS-232C Printer interface: 8-bit parallel interface	1 port D-sub 9-pin connector Centronics D-sub 25-pin connector
Waveform storage	Internal memory Memory card slot x 1 Floppy disk drive x 1 (Option)	Internal memory with backup Memory card conforms to JEIDA*1 Ver.4 and PCMCIA*2 FDD is optional
Calendar	Year, Month, Day, Hour, Minute display	Battery backed-up display ON/OFF
Title input	32 characters max.	
Power		
Battery	MZ5018A Ni-Cd Battery Pack, or MZ5020A Dry Cell Battery Pack	See item (3).
DC input	DC10~18 V	
AC input	100 to 240 V, 50/60 Hz	Using SWA 1702W AC adapter (Item (4))
Power consumption		
DC input	9 W (not charging) 14 W (charging)	Not including option
AC input	50 VA max.	Using SWA 1702W AC adapter
Size Mass	194(H) x 290(W) x 75(D) mm, and 3.2 kg max.	Including optical unit and battery pack (MW0972A, MZ5018A) Not including option

Item	Specification	Remarks
Operating temperature, and humidity	-10° to +40°C, and 85%	• There are limitations on the memory card specifications.
Storage temperature, and humidity	-20° to +60°C, and 85%	
Vibration	MIL-T-28800D (Class 3)	• Not using AC adapter
Drop test	Height 76 cm, 6 surfaces, 8 corners	
EMI	CISPR, Pub. 22 (Class A)	
Dustproofing	MIL-T-28800E	
Waterproofing	MIL-T-28800E	

*1: Japan Electronic Industry Development Association

*2: Personal Computer Memory Card International Association

Number of files saved in memory

Measuring conditions, waveform, and event data can be saved in the internal memory or a memory card.

Note: The number of files which can be saved in any medium may be varied a little depending on the number of fault points and on functions to be added in future.

File	Measurement Mode	FullAuto/Auto Mode *1		Manual Mode	
	Save Format	Analysis Mode	Print Mode	Analysis Mode	Print Mode
Internal Memory		11	123	11	163
Memory Card	256KB (256,000 byte)	11	123	11	163
Memory Card	512KB (516,096 byte)	23	248	23	329
Memory Card	1MB (1,039,360 byte)	47	499	47	499
Memory Card	2MB (2,082,816 byte)	95	1,001 *2	95	1,001 *2
Floppy Disk	2HD (1.44MB)	67	700	67	929
Floppy Disk	2DD (720KB)	33	350	33	350

*1: For ten fault positions

*2: Only 999 files can be listed on the file list of the OTDR although 1,001 files can be saved.

(2) Optical Unit (MW0970A or MW0972A)

Item	Specification MW0970A	Specification MW0972A	Remarks
Wavelength	1310±30 nm	1310±30/1550±30 nm	At 25°C and 1 µs pulse width
Measured fiber	10/125 µm SM fiber	CCITT G.652	
Optical connector Refer to bottom of left page.	FC, SC, ST, DIN or Diamond of PC type User exchangable and cleanable		Any one supplied Biconic and D4 mounted at plant
Distance range	5/10/25/50/100 km		
Pulse width	20/50/100/500/1000/2000 ns		
Dynamic range (S/N = 1)	23 dB min. (1.31 µm) 25.5 dB typ. 20.5 min. (1.55 µm) 22.5 typ.		At 2000 ns Pulse width and Auto measurement
Measurement range*1	15.5 dB min. (1.31 µm) 18 dB typ. 13.0 min. (1.55 µm) 15 dB typ.		At 2000 ns Pulse width and Auto measurement
Dead zone			
Fresnel reflection	10 m		When return loss 25 dB min. with 20 ns Pulse width
Backscattered light	50 m		
Marker resolution	1 m		5 km distance range
Accuracy			
Distance measurement	±2 m ±10^{-4} x measurement range ±marker resolution		Excluding uncertainty due to fiber IOR
Loss measurement (Linearity)	±0.05 dB/dB or ±o.1 dB (whichever larger)		
Return loss measurement	±4 dB		
Real-time sweep	Sweep time of less than 0.9 seconds*2		
Measurement time	180 s min.*3		
Optical safety	Laser: 21CFR Class 1 IEC Class 1		
Size	120(H) x 290(W) x 35(D) mm		
Usage environment	Same as main frame		

Notes:

*1 :0.5 dB splice detection range with ±0.1 dB accuracy by Bellcore TR-NWT-001138 test method

*2 :Measured in the conditions that a 25-km fiber is measured at room temperature in the distance range of 50 km, the approximation method of 2PA, and the normal scale (not zoomed).

*3 :The measurement time is the period from when the [Start] key is pressed until the measurement result is displayed in the table. This time changes according to the fiber loss, Pulse width, and level of Fresnel reflection, and to whether or not Distance range and Pulse width are set to Auto. The typical measurement time is 45 seconds when measuring a 5-km fiber (0.35 dB/km loss) at a wavelength of 1.31 µm with Distance range and Pulse width set to Auto.

MW0973J Optical Unit Specifications

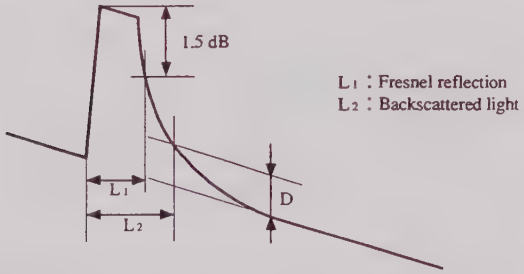
Item	Specifications	Remarks
Wavelength	850±30 nm	At 25°C and 100 ns pulse width
Measured fiber	62.5/125 µm Multimode fiber *1	
Optical connector	FC, SC, ST, DIN or Diamond of PC type User exchangeable and cleanable	Any one supplied
Distance range	5/10/25/50/100 km	
Pulse width	20/50/100 ns	
Dynamic range (S/N = 1)	18 dB	At 100 ns Pulse width and Auto measurement
Measurement range*2	10 dB	At 100 ns Pulse width and Auto measurement
Dead zone		
Fresnel reflection*3	6 m	When return loss 20 dB min. with 20 ns Pulse width
Backscattered light*3	15 m (D=±0.5 dB), 50 m (D=±0.1 dB)	
Marker resolution	1 m	5 km distance range
Accuracy		
Distance measurement.	±2 m ±10^{-4} x measurement range ±marker resolution	Excluding uncertainty due to fiber IOR
Loss measurement (Linearity)	±0.05 dB/dB or ±0.1 dB (whichever larger)	
Return loss measurement	±4 dB	
Real-time sweep	Sweep time of less than 1.0 seconds*4	
Measurement time	180 s min.	
Optical safety	Laser: 21CFR Class 1 IEC Class 1	
Size	120(H) x 290(W) x 35(D) mm	
Usage environment	Same as main frame	

Notes:

*1 : When a 50/125 µm fiber is used, the dynamic range is about 14 dB and the dead zone in backscattered light is about 20 m (0.5 dB).

*2 : 0.5 dB splice detection range with ±0.1 dB accuracy

*3 : See figure below.



*4 : Measured in the conditions that a 2-km fiber is measured at room temperature in the distance range of 5 km, the approximation method of 2PA, and the normal scale (not zoomed).

Appendix A Specifications

MW0975J Optical Unit Specifications

This unit works under the firmware version 4.4 of MW9070A OTDR and covers the following specifications. Values indicated as typical are not guaranteed, or just reference values.

Item	Specifications
Wavelength	850/1300 nm±30 nm (25℃, Pulse width: 100 ns, Typical: ±20 mm)
Measured fiber	62.5/125 μm Multimode fiber *1
Optical connector *2	FC, SC, ST, DIN and HFS-13/A (All are PC type.)
Distance range	5/10/25/50/100 km
Pulse width	20/50/100 ns (Wavelength: 850 nm), 20/50/100/500 ns (Wavelength: 1300 nm)
Dynamic range (S/N = 1)	18 dB (850 nm, Typical: 22 dB)*3, 22 dB (1300 nm)*4
Measurement range*5	10 dB*3(Wavelength: 850 nm), 14 dB*4(Wavelength: 1300 nm)
Dead zone	
Fresnel reflection*6	6 m (850 nm, Typical†: 5 m)*7, 8 m (1300 nm, Typical†: 6 m)*7
Backscattered light*6	50 m (850/1300 nm, D=±0.1 dB), 15 m (850 nm, D=±0.5 dB, Typical†: 9 m) 20 m (1300 nm, D=±0.5 dB, Typical†: 13 m)
Marker resolution	1 m 5 km distance range
Accuracy	
Distance measurement	±2 m ±(10^{-4} x measurement range) ±marker resolution*8
Loss measurement (Linearity)	±0.05 dB/dB or ±0.1 dB (whichever larger)
Return loss measurement	±4 dB
Real-time sweep	Sweep time of less than 1.0 seconds*9
Measurement time	180 s min.
Optical safety	Laser: 21CFR Class 1 IEC Class 1
Size	120(H) x 290(W) x 35(D) mm
Usage environment	Same as main frame

Notes:

*1 :When a 50/125 μm optical fiber is used, the dynamic range becomes narrower by about 4 dB and the dead zone defined by 0.5 dB backscatter level is increased to about 20 m at 850 nm and to about 30 m at 1300 nm.

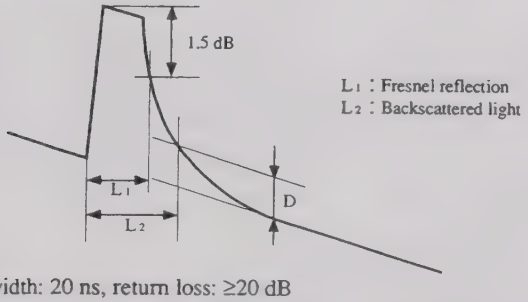
*2 :One of them is supplied as standard. They can be replaced by users.

*3 :At pulse width of 100 ns, in Auto Measurement

*4 :At pulse width of 500 ns, in Auto Measurement

*5 :Range where a 0.5 dB splice can be measured with ±0.1 dB accuracy.

*6 :See figure below.



*7 :Pulse width: 20 ns, return loss: ≥20 dB

*8 :An error caused by fiber refraction index is not included.

*9 :When a 2-km optical fiber is measured at 5 km of distance range, 500 m/div of full scale, and 2PA of Loss measurement.

† :Typical value at ≥30 dB of return loss

Optical Unit (MW0970B or MW0972B)

The following specifications apply when the unit is used with and MW9070A mainframe running software version 5.0 of later. The typical values are given for reference only to assist in the use of the unit, and are not guaranteed specifications.

Item	Specification		Remarks
	MW0970B	MW0972B	
Wave length	1310±30 nm (typical value: ±15 nm)	1310±30/1550±30 nm (typical value: ±15/20 nm)	At 25°C and 1 µs pulse width
Measuring fiber	10/125 µm SM fiber		CCITT G.652
Optical connector	FC, SC, ST, DIN, DIAMOND (All PC type User exchangeable & cleanable)		Any one supplied. Biconic and D4 mounted at plant
Distance range	5/10/25/50/100/200 km		
Pulse width	20/50/100/500/1000/2000/4000/10000 ns		
Dynamic range (S/N=1)	36 dB	36 dB (at 1.31 µm) / 34 dB (at 1.55 µm)	Pulse width of 10 µs, at 25°C
Measurement range*1	22 dB (typical value: 25 dB)	22 dB (at 1.31 µm, typical value: 25 dB) 20 dB (at 1.55 µm typical value: 23 dB)	At 4 µs pulse width and Auto measurement
Dead zone			
Reflective	5 m		Pulse width: 20 ns
Backscatter	25 m (ORL=40 dB)		
Marker resolution	1 m		Distance range: 5 km
Accuracy			
Distance measure	±2 m±10^{-4}×measured distance±marker resolution		Excluding uncertainty due to fiber IOR
Linearity	±0.05 dB/dB or ±0.1 dB (whichever larger)		
Return loss	±4 dB		
Real-time sweep	Sweep time of less than 0.4s*2		
Measurement time	180s min.*3		
Optical safety	Laser: 21CFR Class 1, IEC Class 1		
Size	120 H × 290 W × 35 Dmm		
Usage environment	Same as main frame		

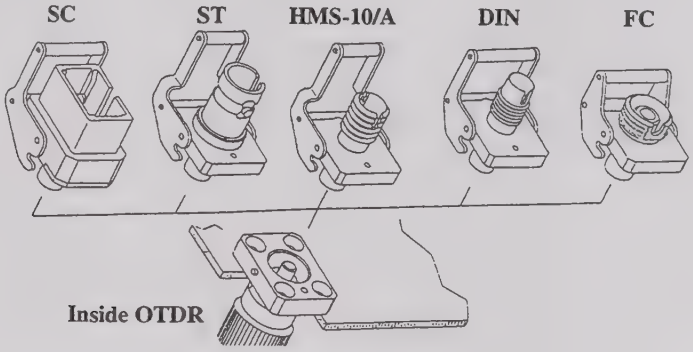
Note:

* 1 0.5 dB splice detection range with ±0.1 dB accuracy by Bellcore TR-NWT-001138 test method

* 2 Measured in the conditions that a 25 km fiber is measured at room temperature in the distance range of 50 km, the approximation method of 2PA, and the normal scale (not zoomed). With MW9070A main frame hardware version 3.0 or later (0.6 s/sweep for hardware version 2.0 or earlier).

* 3 The measurement time is the period from when the [Start] key is pressed until the measurement result is displayed in the table. This time changes according to the fiber loss. Pulse width, and level of Fresnel reflection, and to whether or not Distance range and Pulse width are set to Auto. The typical measurement time is 45 seconds when measuring a 5 km fiber (0.35 dB/km loss) at a wavelength of 1.31 µm with Distance range and Pulse width set to Auto.

Shapes of optical connectors



(3) Battery Pack

(a) Ni-Cd Battery Pack (MZ5018A)

Item	Specification	Remarks
Voltage	10.8 V nominal	
Capacity	2.8 AH nominal	
Cell type	Ni-Cd secondary cell	
Charging time	14 hours min. (20 hours max.)	At 25°C
Charging environment	0° to +40°C	
Continuous operation time	5 hours min.	At 25°C, backlight off
Size	74(H) x 290(W) x 35(D) mm	
Mass	1 kg max.	

(b) Dry-Cell Battery Pack (MZ5020A)

Item	Specification	Remarks
Cell type	Dry cell battery (R14 or LR14)*	10 batteries Batteries are not included.
Size	74(H) x 290(W) x 35(D) mm	
Mass	450 g max.	Without dry cell battery

* Size: C or Baby

The operation time of alkaline dry cell battery and manganese dry cell battery is listed below. (Typical value)

Cell type	Main unit backlight	Environment		
		-10°C	25°C	40°C
Alkaline Dry Cell Battery (LR14)	ON	40 minutes	4 hours	7 hours
	OFF	2 hours	13 hours	15 hours
Manganese Dry Cell Battery (R14)	ON	20 minutes	1 hour	2 hours
	OFF	1 hour	4 hours	6 hours

(4) AC Adapter (SWA1702W)

Item	Specification	Remarks
AC input	100 to 240 Vac, 50/60 Hz	
DC output	17.5 Vdc, 1.2 A	
Size	36(H) x 163(W) x 63(D) mm	
Safety standards	UL1950, CSA1402C, EN60-950	
Operating temperature, and humidity	0° to +40°C, and 90%	
Storage temperature, and humidity	-10° to +70°C, and 95%	

(5) Built-in 3.5 inch FDD (MW9070A-01)

Item	Specification	Remarks
Storage medium	3.5"FD (2DD or 2HD)	
Format	MS-DOS	
Storage capacity	2DD (720KB), 2HD (1.2 MB or 1.44 MB)	
Power consumption	4W at DC input Included in max. value at AC input	
Mass	3.5 kg max.	Including main frame, optical unit and battery pack (MW0972A, MZ5018A)
Operation temperature, and humidity	+5°~ 40°C, 85%	At FDD operation
Operation condition	The screen of the main frame is horizontal or the stand is set to incline the screen from the vertical position.	At FDD operation

(6) Visible LD Light Source (MW0970A-05/MW0972A-05/MW0973J-05/ MW0975J-05/MW0970B-05/MW0972B-05)

Item	Specification	Remarks
Center wavelength	635±10 nm	At 25°C
Optical output	-3.0±1.5 dBm	
Output fiber	10/125 µm SM fiber	
Optical connector	FC, SC, ST, DIN, or Diamond (User exchangeable) D4 and Biconic (Mounted at plant)	
Optical safety	IEC Class 2 21CFR Class 2	

(7) Hard Carrying Case (Z0243)

Item	Specification	Remarks
Size	500(H) x 380(W) x 235(D) mm	
Mass	4.5 kg max.	

(8) Peripherals and Parts

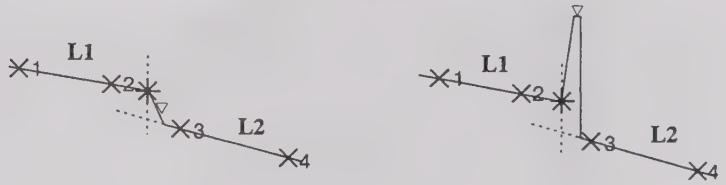
Name	Specification	Model
AC adapter	Input voltage: 100 to 240 Vac, 50/60 Hz	SWA1702W
Power cord	2.5 m 1 pc.	J0017
MW9070A Operation manual		M-W0683AE
MW9070A Serial interface Operation manual		M-W0751AE
MW9070A Service manual		M-W0683BE
Thermal printer	120 V ±10%, 60 Hz	DPU-411-21BU
Thermal printer	220 V ±10%, 50 Hz	DPU-411-21BE
256 KB memory card	JEIDA Ver.4	JS256G3-C-13
512 KB memory card	JEIDA Ver.4	JS512G3-C-13
1024 KB memory card	JEIDA Ver.4	JS1024G3-C-13
2048 KB memory card	JEIDA Ver.4	JS2048G3-C-13
Printer connection cable	Centronics	J0614
FC type adapter		FC-AP
Optical fiber cable	with FC-PC at both ends for SM fiber	J0486□*1
FDDI-FC conversion cable		J0699□*1
FDDI-ST conversion cable		J0700□*1
FDDI-SC conversion cable		J0701□*1
Connector cleaning set		MZ8012A
Soft carrying case	Handbag type	Z0242
Hard carrying case	Main frame, unit, thermal printer Optical loss test set can be contained	Z0243
Replaceable FC optical connector		J0617B
Replaceable ST optical connector		J0618D
Replaceable DIN optical connector		J0618E
Replaceable HMS-10/A optical connector		J0618F
Replaceable SC optical connector		J0619B
Serial interface cable	For remote control with IBM-PC/AT or J-3100	J0654A
Serial interface cable	For peripheral equipment	J0661A
Printer paper for DPU-411/DPU-412	10 rolls/set	TP411-28CL

Notes:

*1 Specify A to C at the □ mark according to the length of the cable (A: 1 m, B: 2 m, C: 3 m).

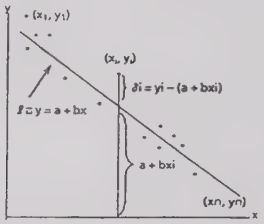
Appendix B Least Square Linear Approximation Method

When splice loss is measured, two lines, L1 and L2, are determined from the measurement data as shown below and the loss is found.



There are two methods for determining these lines: the LSA, and 2PA methods (section 1.5). The LSA (Least Square Approximation) method is explained here.

In the Least Square Approximation method, the straight line that best fits all the measurement data points between the markers is found.



As shown in the above diagram, the straight y = a + bx is the best fit for n data points (x_1, y_1), (x_2, y_1), ... (x_n, y_n). The value of the deviation of each point (δ1, δ2, δ3) including the variables a and b from the line, L, is found, and the line, L, is determined from variables a and b so that the sum, E, of the square of the deviation, δi, of each point is the minimum value.

$\delta i = yi-(a+bxi)$

$$E = \sum_{i=1}^{n} \delta t^2 = (y_1-a-bx_1)^2+(y_2-a-bx_2)^2+ \cdots +(y_n-a-bx_n)^2$$

In this method, the condition required to minimize E is:

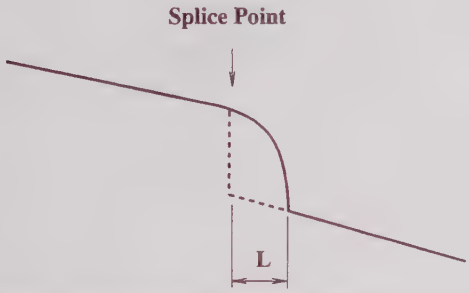
$$\frac{\delta E}{\delta a} = 0, \quad \frac{\delta E}{\delta b} = 0$$

When this equation is solved, the variables a and b can be found as shown below and the line, L can be determined as follows:

$$a = \frac{\bar{y}\sum_{i=1}^{n}(xi)^2 - \bar{x}\sum_{i=1}^{n}(xiyi)}{\sum_{i=1}^{n}(xi)^2 - n(\bar{x})^2}, \qquad b = \frac{\sum_{i=1}^{n}(xiyi) - n\bar{x}\bar{y}}{\sum_{i=1}^{n}(xi)^2 - n(\bar{x})^2}$$

where, $\bar{x} = \frac{1}{n}\sum_{i=1}^{n}(xi), \quad \bar{y} = \frac{1}{n}\sum_{i=1}^{n}(yi)$

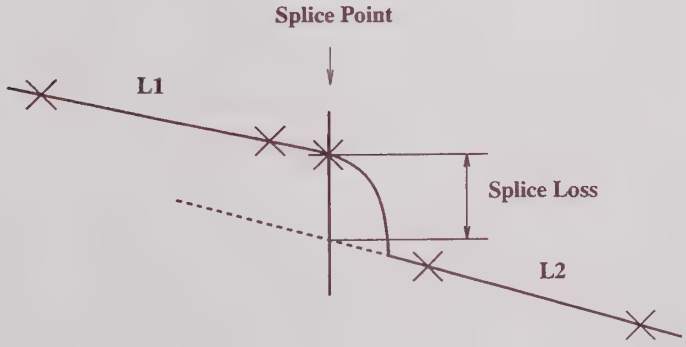
The trace waveform at the splice point should be displayed as the dotted line in the figure below, but is actually displayed as the solid line. The waveform input to the OTDR shows a sharp falling edge at the splice point, so the circuit cannot respond correctly. The interval L gets longer as the pulse width becomes longer.



Therefore, the splice loss cannot be measured conectly in the Loss mode.

In the Splice & Return Loss mode, two markers are set on each side of the splice point and the lines L1 and L2 are drawn as shown below. The part of the straight line immediately after the splice point is the forward projection of the straight line, L2.

The splice loss is found by dropping a vertical line from the splice point to this projection of L2 and measuring the level difference between the splice point and the intersection.



Appendix D Return Loss Measurement Principle

The return loss, R, is found from the following calculation.

where, $R = -(10\log_{10}bsl + 10\log_{10}(10^{L/5}-1))$

$$bsl = S \cdot \alpha_R \cdot V \cdot \frac{W}{2}$$

$$S = K \cdot \frac{N1^2 - N2^2}{N1^2}$$

$$V = \frac{C}{N_e}$$

W (sec):	Currently-set pulse width
L:	Difference of levels between ✳ and ▽ markers
$BSL = 10\log_{10}bsl$:	Backscattered light level
S :	Backscattered coefficient
α_R:	Rayleigh Scattering Loss (np/m)
	$= 0.23026 \times 10^{-3} \times RSL$
RSL:	Rayleigh Scattering Loss (dB/km)
V:	Group velocity in optical fiber
K:	Constant determined by optical fiber
N1:	Index of refraction of optical fiber core
N2:	Index of refraction of optical fiber cladding
N_e:	Effective group index of refraction of optical fiber
C (m/s) :	Speed of light (2.99792458×10^8)

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